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LONG AND SHORT RUN ECONOMIC FORECASTS FOR BOSTON AND ITS METROPOLITAN AREA

by

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ABSTRACT

The economy of the Boston Metropolitan Area depends upon the course of national economic growth because of its diversity and because of the geographical size of the Boston Metropolitan Area as a production center relative to the size of the geographical area over which its products and services are consumed. Local economic growth is forecasted at rates below the national average and below other, but much larger, regions of the country. The local growth rate in production is forecast at about 90% of the rate of growth of Gross National Product.

The 1960 level of Gross Production in the Metropolitan Area is about eight billion dollars. In twenty years local production is expected to increase to between 13 and 17 billion 1959 dollars. Over the same period, population is expected to increase from the present 2.5 million to between 3 and 3.4 million persons. The earnings of the people, presently about $2,460 per capita, is expected to increase to between $3,000 and $4,000 per person by 1980 depending upon the vigor of national economic growth.

Implicit in these economic forecasts is the assumption that suitable measures will be taken within the Boston Metropolitan Area to maintain and enhance the area's ability to compete effectively in distant markets. The assumption is that capital investment in plant and equipment adequate to achieve respectable growth in productivity will occur. It is assumed also that progress will be made in the achieving of a land use pattern, an array of social and economic activities in space, and a system of transportation facilities that will minimize the cost of internal movements of people and goods.

Forecasts for the Boston Metropolitan Area were prepared using an interregional technique through which the local economy could be related to economic patterns in other parts of the country. The technique was developed by Walter Isard during the early 1950's and this instance is the first full scale application of the method for preparing local economic forecasts. As such, the study makes a modest contribution to the body of tested economic analysis and forecasting techniques.

In the course of this study, much of the time-consuming and costly work that must be completed prior to analyzing and forecasting has been completed once and for all. Subsequent applications of the method either in up-dating the forecasts or in conjunction with other studies will involve only the collection of the most recent information -- all of the historical data has been collected and recorded and the computer programs of the method are complete. The study group recommends that the work begun here be picked up by others engaged in economic research and be developed further as part of their work program.

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Part I

BOSTON AND THE METROPOLITAN AREA, A NATIONAL ECONOMIC FORCE

Section A: INTRODUCTION AND OBJECTIVES

This study of the economy of Boston and the Boston Metropolitan Area is a joint venture between the Greater Boston Economic Study Committee, the Planning Department of the Boston Redevelopment Authority, formerly under the Boston City Planning Board, and the Boston and Maine Railroad.

Each of the collaborators contributed to the carrying out of the study. The Greater Boston Economic Study Committee contributed the cost of publication and the cost of recording on punched cards the basic economic data required for the study. The Boston and Maine Railroad made available their electronic data processing equipment for making the mathematical computations required and for tabulating the results. The Planning Department provided the personnel for carrying out the study.

The study was undertaken for two reasons. First, the objective of the study was to conduct a comprehensive economic base study for the Boston area, which has been lacking for some time. The findings of the study are to be made available for use by planners and decision makers of the area's businesses and institutions. Second, the study was undertaken because the methodology employed had not been used operationally subsequent to the theoretical statement of the method in the early 1950's. Thus, the moulding and shaping of the method for carrying out an economic analysis and forecast for Boston

not the objective

and the Boston Metropolitan Area would represent a contribution to the body of urban and regional economic study techniques.

In the following pages the findings of the study are presented in Part I. Part II deals with an evaluation of the economic forecasts; their nature and value. Finally, in Part III, the methodology used in carrying out the study is described.

Section B: FINDINGS OF THE STUDY

The economy of the Boston Metropolitan Area is vitally linked to the economy of the rest of the nation because many of the goods and services produced here are purchased by capital from outside of the area. The relatively small geographical size of the metropolitan area in relation to the area for which it produces, indicates this function. Historically, the economy of the Boston Area has depended upon outside markets,and forecasts based upon national growth patterns indicate a strengthening of the Boston Area's position as an exporter of goods and services.

The strong economic relationship between Boston and the rest of the nation requires that local forecasts be prepared within the broader framework of economic forecasts for the nation. Two forecasts of economic activity have been prepared for Boston and its Metropolitan Area based upon the growth of Gross National Product at three and four percent annually. A three percent growth rate, the long-run growth rate of Gross National Product,[*] represents a continuation of the long-run historical growth rate. Some think that this rate is likely to persist in the long run.[+]

---

[*] The historical analysis of the growth in Gross National Produc during the period from 1897 to 1959, performed by the National Industrial Conference Board (Forty Years of Economic Growth) indicated a three percent annual growth. The U.S. Department of Commerce found a three percent annual growth rate in an analysis of the years of high level economic activity between 1909 and 1957. See "Looking Ahead at the Nation's GNRP," Business Record, (June 1960) 16-19.

[+] Ibid., P. 16

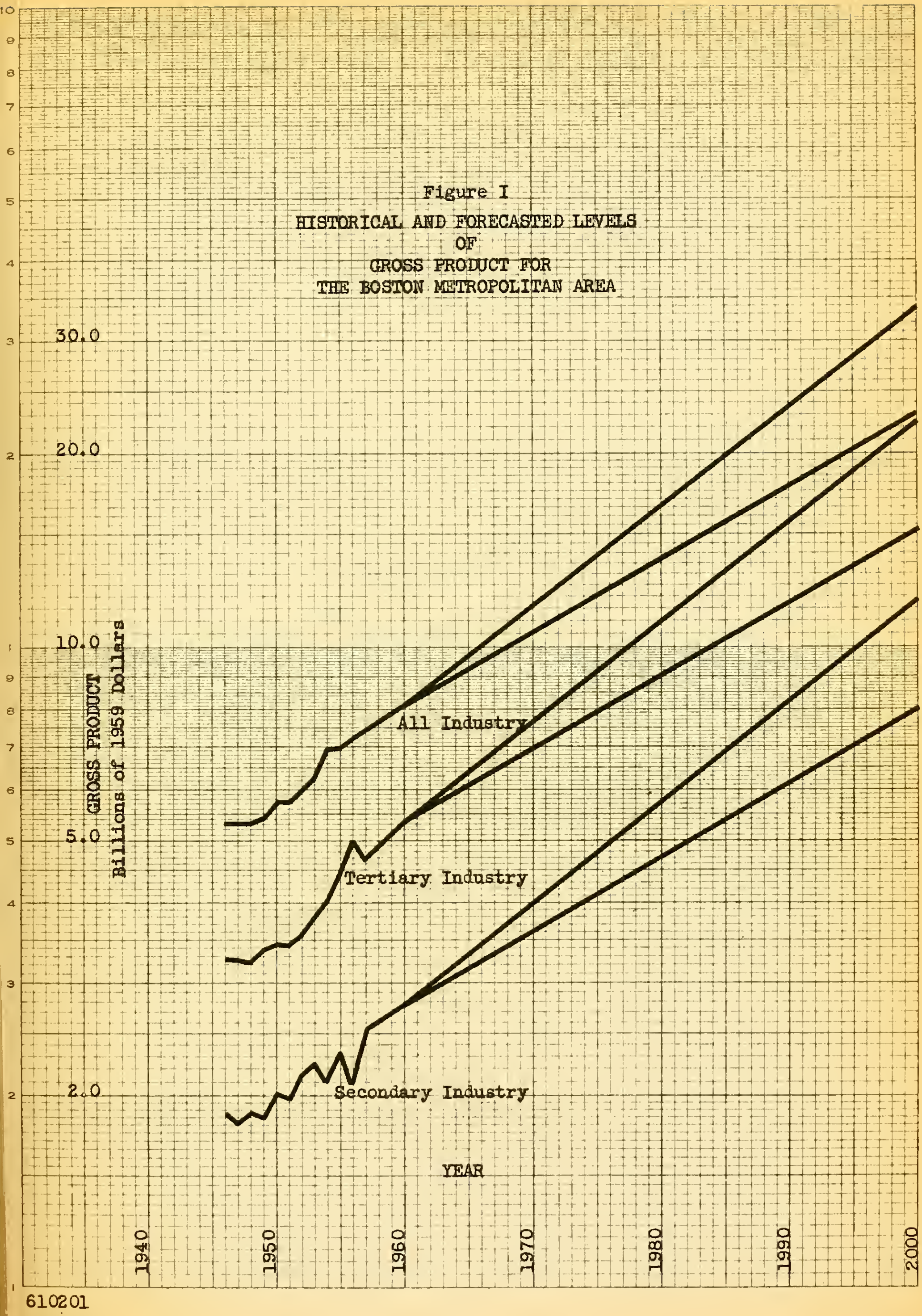

Figure I

HISTORICAL AND FORECASTED LEVELS
OF
GROSS PRODUCT FOR
THE BOSTON METROPOLITAN AREA

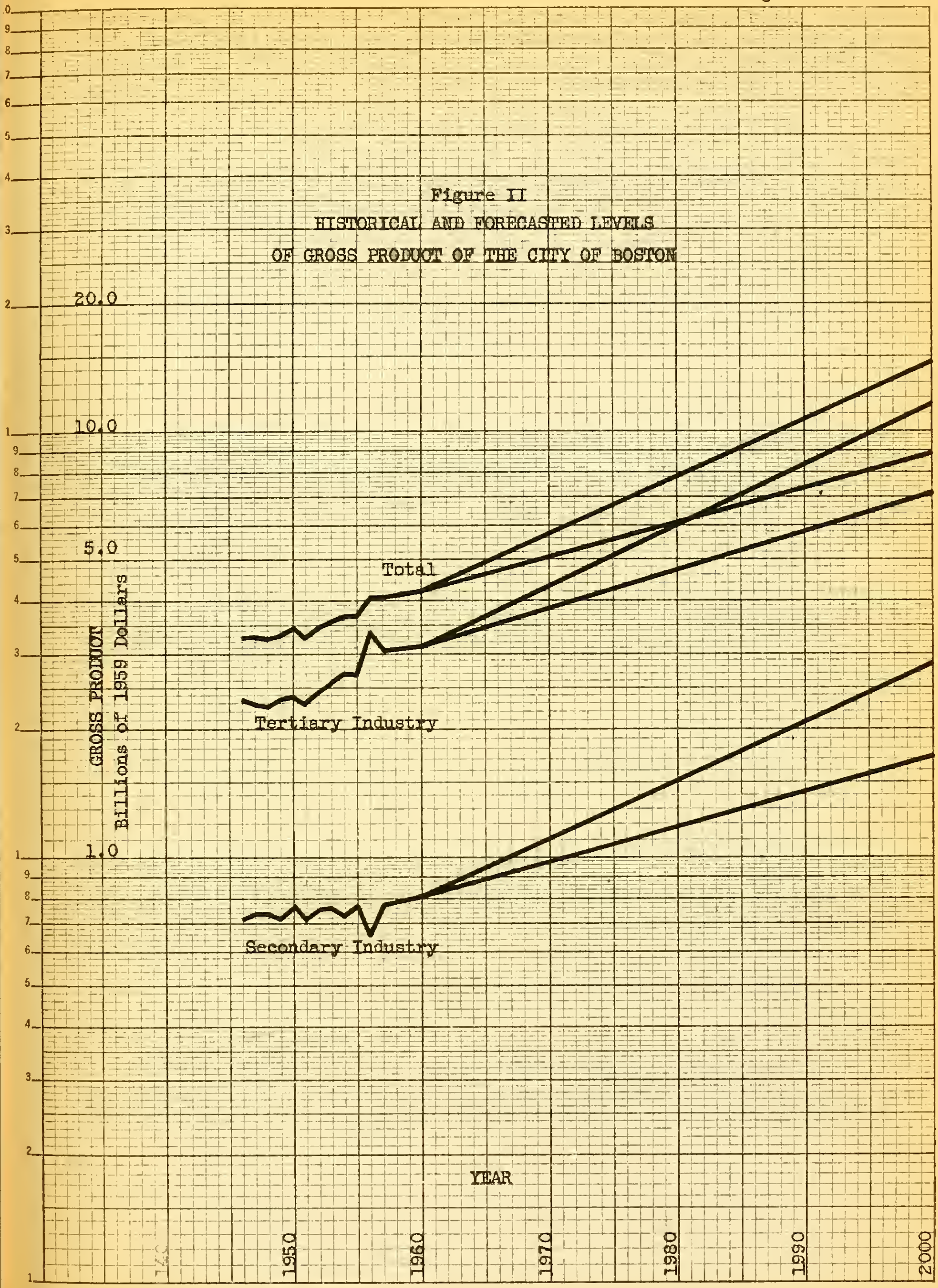

Figure II

HISTORICAL AND FORECASTED LEVELS

OF GROSS PRODUCT OF THE CITY OF BOSTON

Other economists suggest that the annual gain in Gross National Product could approximate the post-war rate of four percent, while others suggest that six percent is feasible.* Four percent, however, seems to be a level at which private enterprise may sustain growth with only nominal governmental interference.

? vague word

The Prospects for Boston and Its Metropolitan Area

Economic Changes

The prospects for future economic growth in the Boston Metropolitan Area are reasonably good although local economic growth is tied very closely to national growth patterns. The presentation of the findings of the study relative to local growth is in terms of changes in gross production, labor force, and productivity, location and resource potential and in the composition of the economy.

Output

The rate of growth of the value of the production, the Gross Product, of the Boston Metropolitan area has, historically, followed closely the growth pattern of Gross National Product. The future annual rate of growth is forecasted at about ninety percent of the national rate of growth, i.e., 2.69 to 3.67 percent. At these rates, the present Gross Product of eight billion dollars should double by

? not clear

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[*] Ibid., passim. Rates of growth higher than four percent have been used to make forecasts of Gross National Product by the National Planning Association, the Joint Economic Committee, and Fortune Magazine.

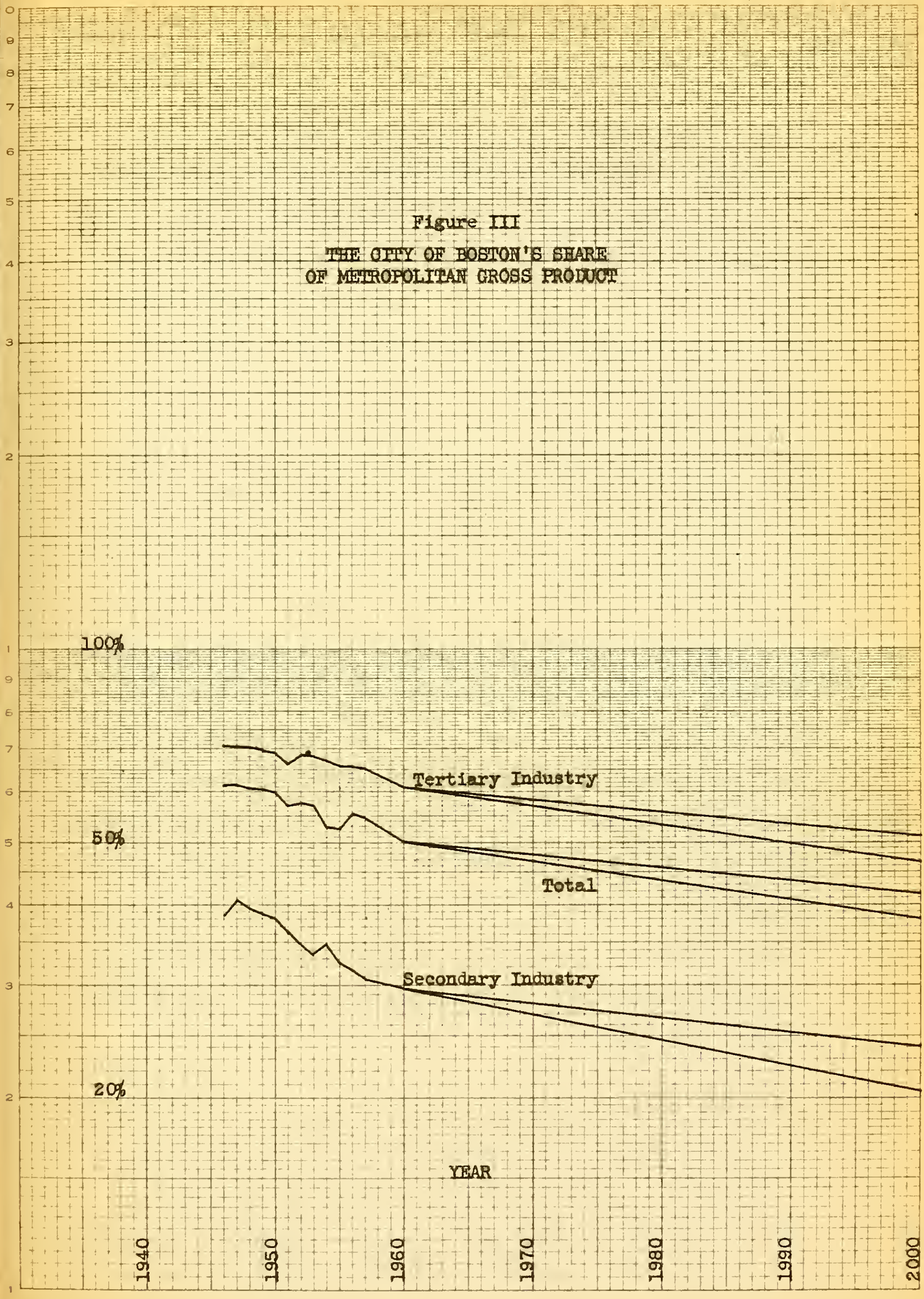

Figure III

THE CITY OF BOSTON'S SHARE OF METROPOLITAN GROSS PRODUCT

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the period 1978 to 1984. The forecast of Gross Product for the year 2000 is between twenty-three and thirty-four billion dollats. Gross Product per capita, in the year 2000 is forecasted at about 1.6 to 2.9 times greater than in 1960. The historical and forecasted levels of production in the Boston Metropolitan Area and in the City of Boston are shown in Figures I and II.

The relative distribution of economic activity within the Metropolitan Area between the city and the suburbs, will shift because of the differential rates of growth of Gross Product. In 1950, sixty percent of the total metropolitan production occurred in Boston. By 1959, this had declined to fifty-two percent. By the year 2000, Boston's share of total metropolitan production will be between thirty-eight and forty-two percent. The historical and forecasted share of metropolitan economic production in the City of Boston is shown in Figure III.

need not mean absolute decline

The percentage of the total metropolitan production generated by Primary Industry (Agriculture, Forestry, and Fisheries), Secondary Industry (Mining, Construction, and Manufacturing), and Tertiary Industry (all other) in the future is expected to remain about the same as at present. Primary Industry will not grow much; its Gross Product will grow at a much slower rate than the total production and thus will decline as a percentage of the total. Off-setting this decline is a slight increase in the percentage contributed by Tertiary Industry.

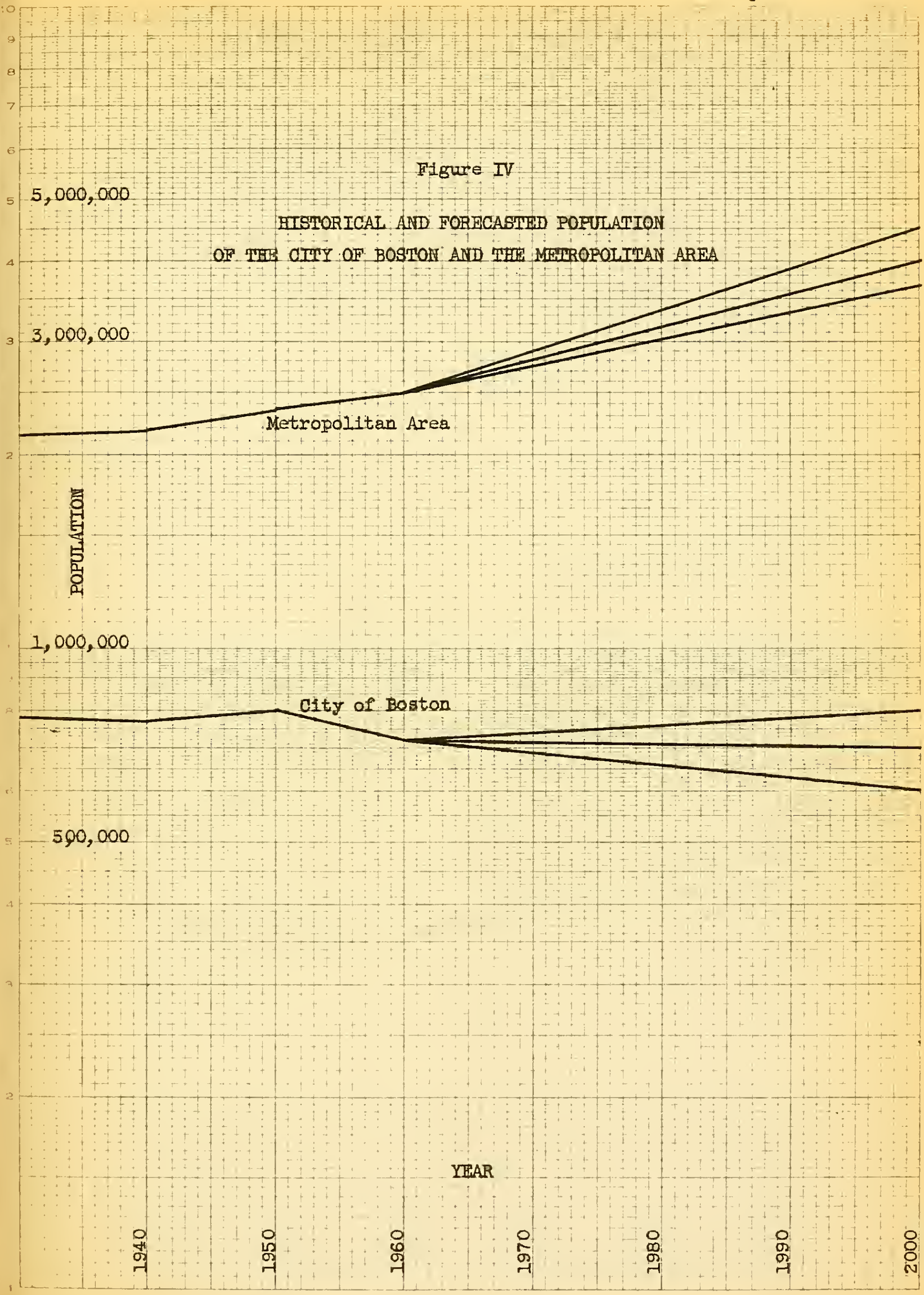

Figure IV

HISTORICAL AND FORECASTED POPULATION
OF THE CITY OF BOSTON AND THE METROPOLITAN AREA

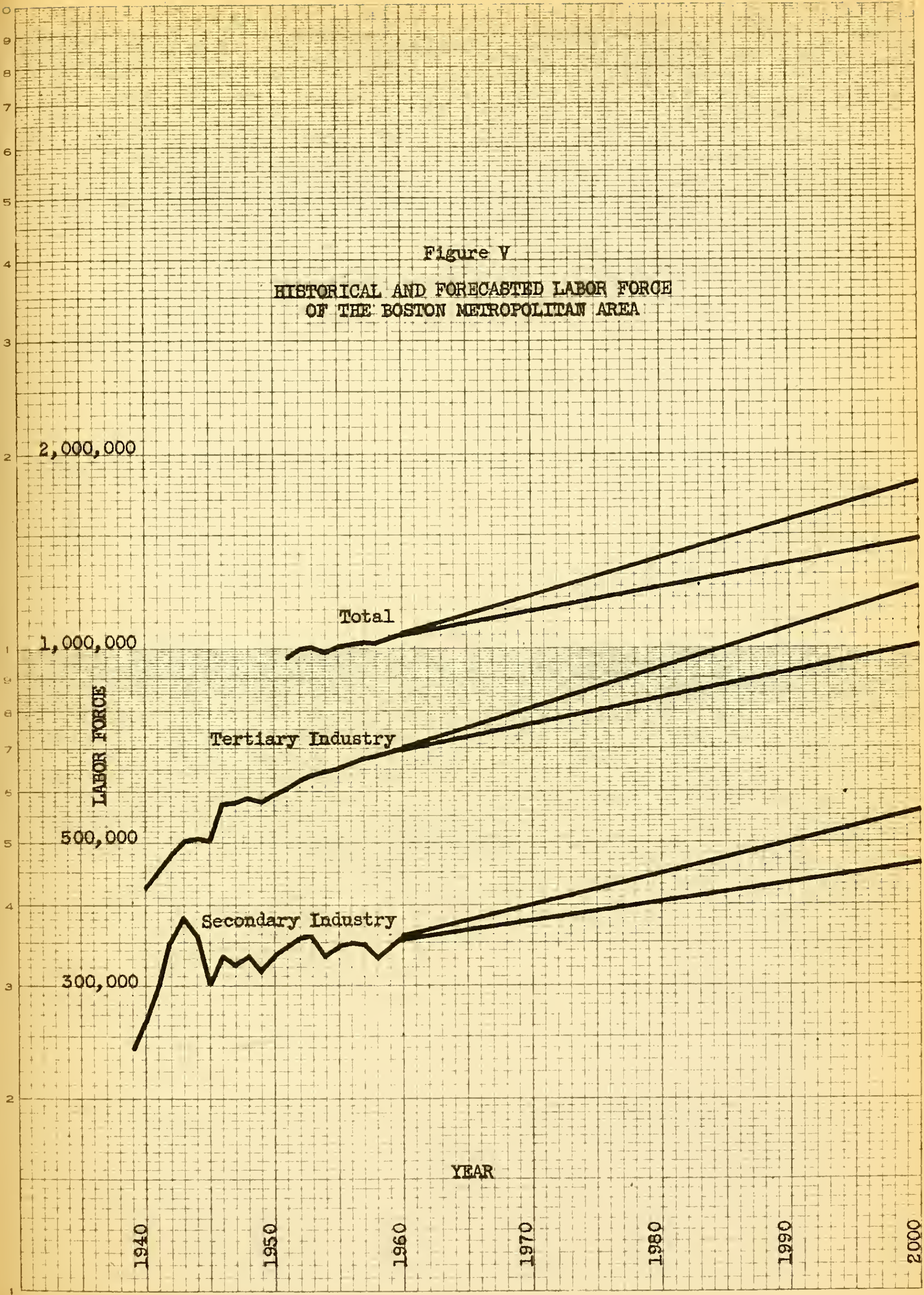

Figure V

HISTORICAL AND FORECASTED LABOR FORCE OF THE BOSTON METROPOLITAN AREA

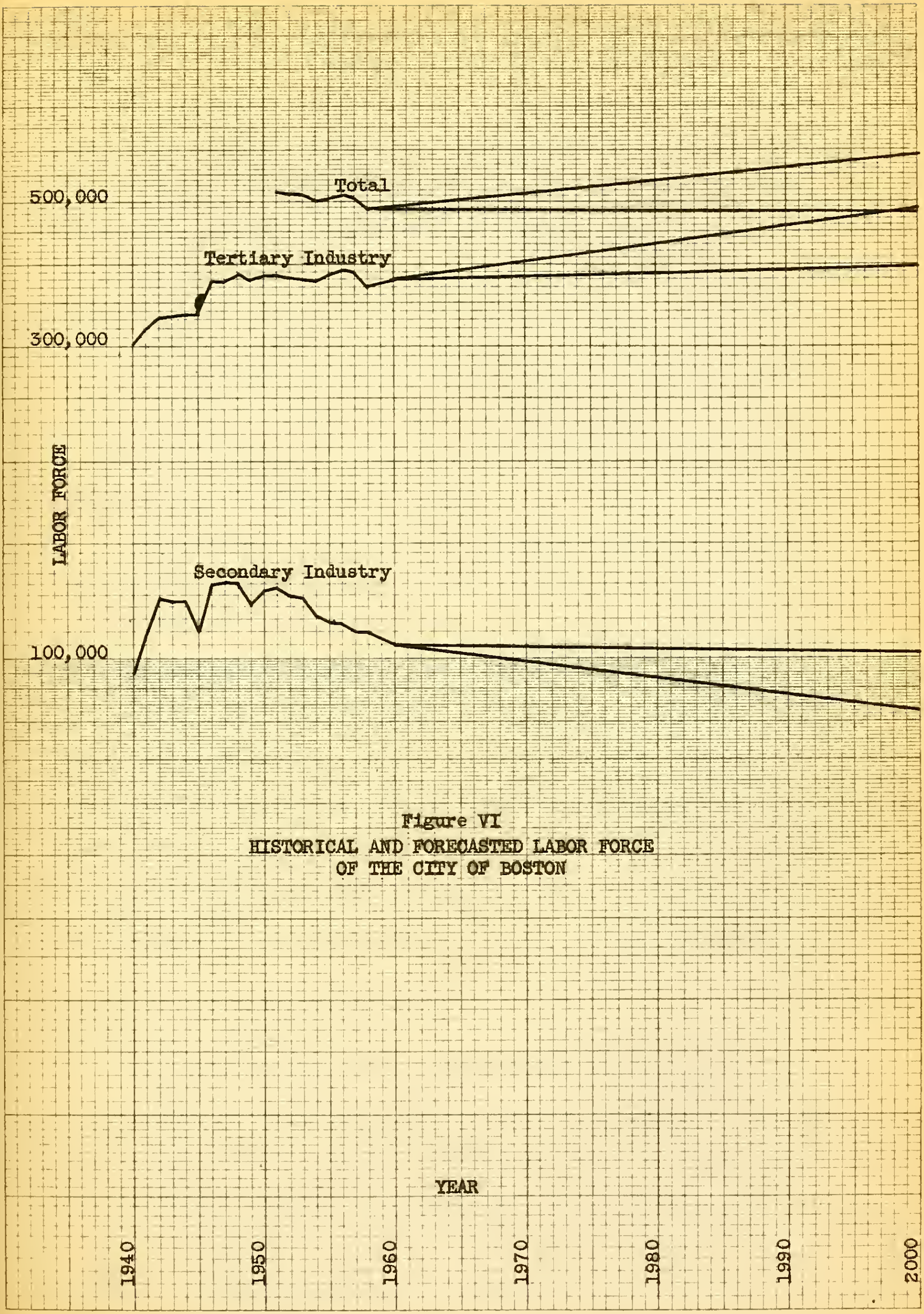

Figure VI
HISTORICAL AND FORECASTED LABOR FORCE
OF THE CITY OF BOSTON

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Input

The productive capacity of the Boston Metropolitan Area will be expanded by increases in the labor force and by a rise in worker productivity. The metropolitan labor force engaged in production is expected to rise to between 1.25 and 1.37 million workers by 1980 and to between 1.47 and 1.8 million by the year 2000 from about 1.05 million in 1960. The rate of increase of labor force is generally higher than the rate of increase in the forecasted metropolitan population growth due to a predicted slight increase in the participation of the population in the labor force. The forecasted population and labor force may be seen in Figures IV, V, and VI.

The expansion of the productive capacity of the Boston Metropolitan Area is caused primarily by an expansion of the productive capacity of labor and secondarily by the expansion of the labor force. The expansion of the labor force is forecasted within the range of .2 and 1.38 percent increase annually. To maintain a rate of growth in total production at 2.69 percent, the productivity of labor must increase between 1.4 and 1.8 percent annually. To achieve a 3.67 percent growth in production, labor productivity must increase at between 2.2 and 2.6 percent annually. The growth pattern of productivity in the Metropolitan Area and in the United States is shown in Figure VII.

why these decimals?

Income

Forecasts consistent with growth of Gross Product of Gross Personal Income for the Metropolitan Area indicate an increase to between 10.. and 13.' billion dollars by 1980 and an increase to between 17.74 and 26.25 billion dollars by the year 2000. This represents a change

forecast

be dashed ?

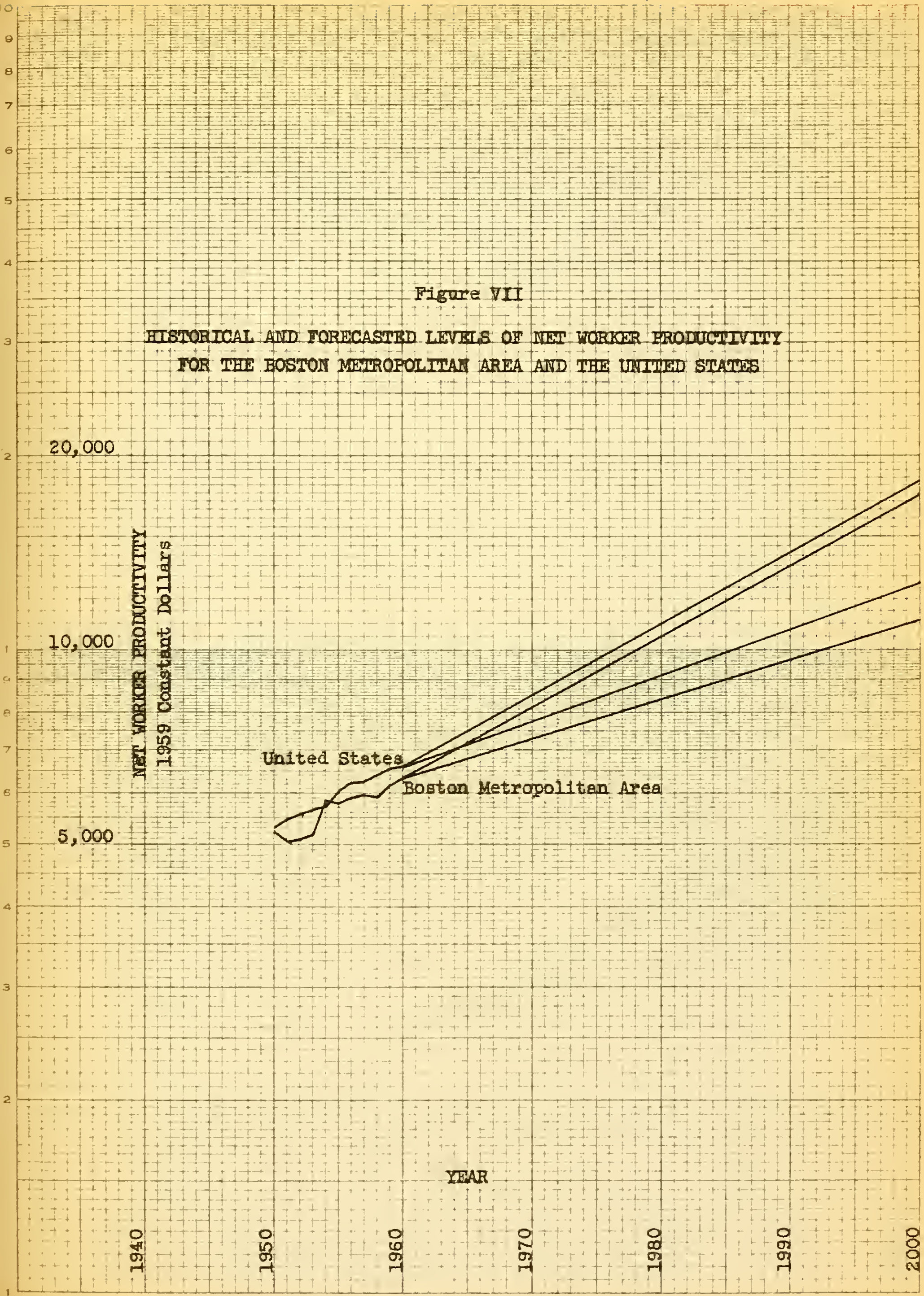

Figure VII

HISTORICAL AND FORECASTED LEVELS OF NET WORKER PRODUCTIVITY FOR THE BOSTON METROPOLITAN AREA AND THE UNITED STATES

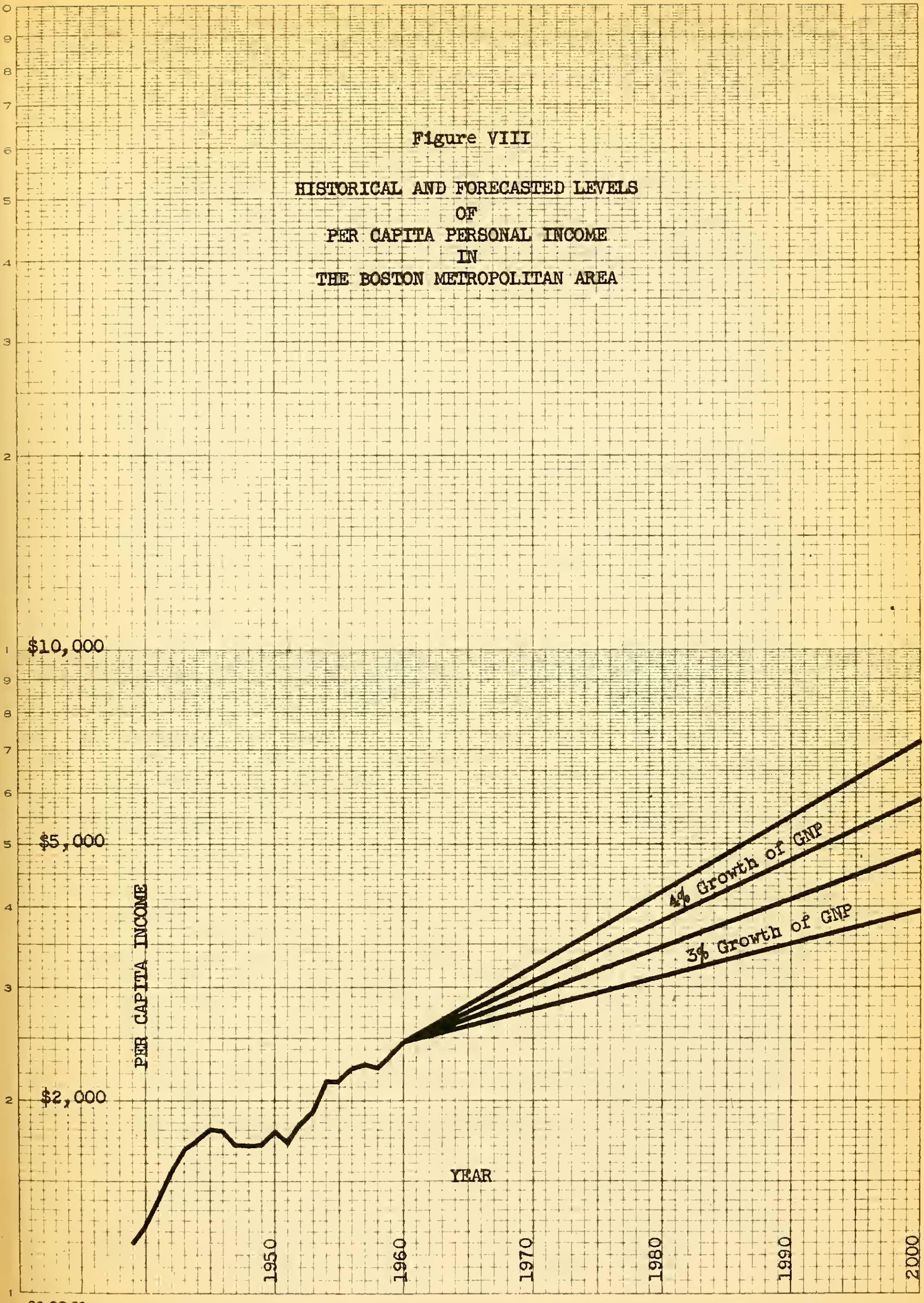

Figure VIII

HISTORICAL AND FORECASTED LEVELS OF PER CAPITA PERSONAL INCOME IN THE BOSTON METROPOLITAN AREA

in per capita income from the present $2400 to $2450 to between $2985 and $4295 in 1980 and to between $3942 and $7192 in the year 2000. This is shown in Figure VIII.

Location and Resource Potential

Highly urbanized areas such as the Boston Metropolitan Area exist because of this locational and resource advantages relative to a much larger geographical area. To a marked extent the growth of production in the Metropolitan Area is dependent upon an increase of demand in the hinterland for its goods and services.

Historically, the Boston Metropolitan Area's production has been stimulated by increases in demand in the hinterland. Forecasts of Gross Product for the Boston area indicate a growth not merely because of the increases in the local labor force and increases in the productivity of the labor force but because of the increasing income and population in the other regions of the nation.

Relative to the other regions of the country, the Boston Metropolitan Area is not growing as rapidly.. . Its population, labor force and Gross Product are growing more slowly than any region considered [illegible] ? in this study. However, because of the increases in population, income and economic activity within the other regions of the nation, the amount of goods and services produced in the Boston Metropolitan Area for consumption in other regions is expected to increase. Thus, external expansion of demand is stimulating the growth of the local economy; and forecasts indicate that continued external growth will be essential for maintaining adequate growth locally.

The Composition of the Economy of Boston and its Metropolitan Area

The growth of total production in the Boston Metropolitan Area reflects the net result of declines in certain types of economic activity and the growth of other types. Forecasts of economic activity have been prepared for three sectors of the local economy: Primary Industries, Secondary Industries, and Tertiary Industries.

Primary Industry

Included in the category of Primary Industry are Agriculture, Forestry and Fisheries. At present the percentage of employment in Primary Industry and the percentage of Gross Product contributed directly by Primary Industry amounts to less than one percent of the total. Forecasts of this sector of the local economy indicate that the production of these industries may increase slightly though the percentage of the total production contributed by Primary Industry will decline. No specific forecasts for the Boston Metropolitan Area were prepared for Primary Industry.

Secondary Industry

The category of Secondary Industry includes Manufacturing, Construction and Mining. Approximately thirty-five percent of the Gross Product of the Boston Metropolitan Area is generated by Secondary Industry. Secondary Industry employs a like share of the total metropolitan labor force. Historically, this sector has shown relative stability in its share of total output and total employment opportunities.

The metropolitan gross product in 1960 produced by Secondary Industry is estimated at 2.6 billion dollars. Forecasts for this sector indicate that by 1980 the Gross Product will increase to between 4.7 and 5.6 billion dollars and by the year 2000, gross product will rise to between 8 and 12 billion dollars. Within the City of Boston the 1960 Gross Product for Secondary Industry was .82 billion dollars. By 1980, Gross Product is expected to rise to between 1.2 and 1.5 billion dollars and the forecast for the year 2000 is between 1.7 and 2.8 billion dollars. This may be seen in Figures I and II.

While the Gross Product of Secondary Industry is rising in the Boston Metropolitan Area and in the City of Boston, the metropolitan growth is from twenty-five to fifty percent faster than that of the city. Gross Product in the City of Boston is expected to grow at between 1.9 and 3.1 percent annually while the metropolitan growth forecast is between 2.7 and 3.9 percent annually.

As a result of this differential growth pattern, a relative shift of this activity within the metropolitan area is expected. At present, the City of Boston generates about thirty percent of the total Gross Product in Secondary Industry. By the year 2000, the city's share is expected to decline to between 21.5 and 24.2 percent. This is illustrated in Figure III.

Accompanying the relative decline in Gross Product generated in Boston is a relative decline in the employment opportunities in Secondary Industry in the city. At present, the metropolitan employment in Secondary Industry is about 355 thousand. The metropolitan employment forecast for 1980, is about 435 thousand and for the year 2000, the

forecast is between 460 and 560 thousand workers. However, in the City of Boston, the present employment is about 165 thousand. The employment forecast for 1980 is between 92 and 108 thousand, and for the year 2000, it is between 110 and 80 thousand.

The present productivity of metropolitan workers in Secondary Industry is estimated to be about $6250 annually. Growth in worker productivity with four percent expansion of the national output is forecasted at between 2.9 and 2.6 percent annually and at the rate of 1.45 and 1.9 percent annually if national economic expansion occurs at three percent. By 1980, worker productivity will range between $8500 and $10,500 annually, and by the year 2000, productivity is forecasted to be between $11,400 and $17,600 per year.

Tertiary Industry

Included in the category of Tertiary Industry are the remaining economic activities that were not classified in either the Primary or Secondary Industry category. They are: Transportation and Public Utilities; Wholesale and Retail Trade; Finance, Insurance and Real Estate; Government; Science; and Miscellaneous.

Approximately two-thirds of the Gross Product of the Metropolitan Area is generated by Tertiary Industry. The Gross Product generated by Tertiary Industry in 1960 is estimated at 5.1 billion dollars. It is expected that this sector of the metropolitan economy will grow at between 2.7 and 3.7 percent annually. At these rates of growth, the production should double by the period 1978 to 1984 and range between 15 and 23 billion dollars by the year 2000.

Forecasts for the City of Boston indicate that the level of Tertiary production will rise from the present 3.24 to 3.32 billion dollars to between 7.1 and 11.6 billion dollars by the year 2000. This is shown in Figures I and II.

At the present time 64 percent of the metropolitan product of Tertiary Industry is generated within the City of Boston. By the year 2000 the City of Boston's participation is estimated to be 46 percent of the metropolitan Tertiary Industry Gross Product.

that much decline? What in absolutes?

The high growth rate in this sector of the economy is a result of increases in worker productivity and an expansion of the labor force. The rate of growth of worker productivity is forecasted at between 1.5 and 2.9 percent annually. At these rates, worker productivity will increase from the present $6,200 annually to between $8000 and $11,300 by 1980 and to between $11,000 and $19,800 by the year 2000.

The metropolitan present labor force employed in Tertiary Industry is estimated at between 686 and 706 thousand. A relatively high growth in the labor force of this sector is predicted off-setting the relative decline in Primary Industry and the low growth rate of Secondary Industry. This prediction is based upon the apparent increase in the consumption of services resulting from an increase in leisure time, etc. The metropolitan labor force of this sector is forecasted at between 830 and 902 thousand by 1980 and at between 1,007 and 1,167 thousand by the year 2000; see Figure V.

Forecasts for the City of Boston indicate an increase in Tertiary Industry employment from the present 390 thousand to between 397 and 488 thousand by the year 2000. This may be seen in Figure VI.

64% of the product

Approximately 56 percent of the present metropolitan labor force engaged in Tertiary Industry is employed in the City of Boston; by the year 2000, the city will employ between 39 and 42 percent; see Figure III.

46% of the Product

* what does the diff betw. prod. & L.F. mean?

LOCAL-NATIONAL ECONOMIC PATTERNS

The economic forecasts for the Boston Area were based upon National economic forecasts. Discussed below are the historical and forecasted patterns of the nation in comparison with those of the Boston Area and the nature of the relationships identified and assumed to exist between social and economic variables.

National Historical Patterns and Forecasts

The discussion of patterns and forecasts will be in terms of gross production, population and labor force, and net productivity of labor. Subsequently, the relationships between the variables will be identified and how these relationships were used in preparing forecasts is discussed.

? Poor sentence

Gross National Product

How fast historically the Gross National Product has been growing

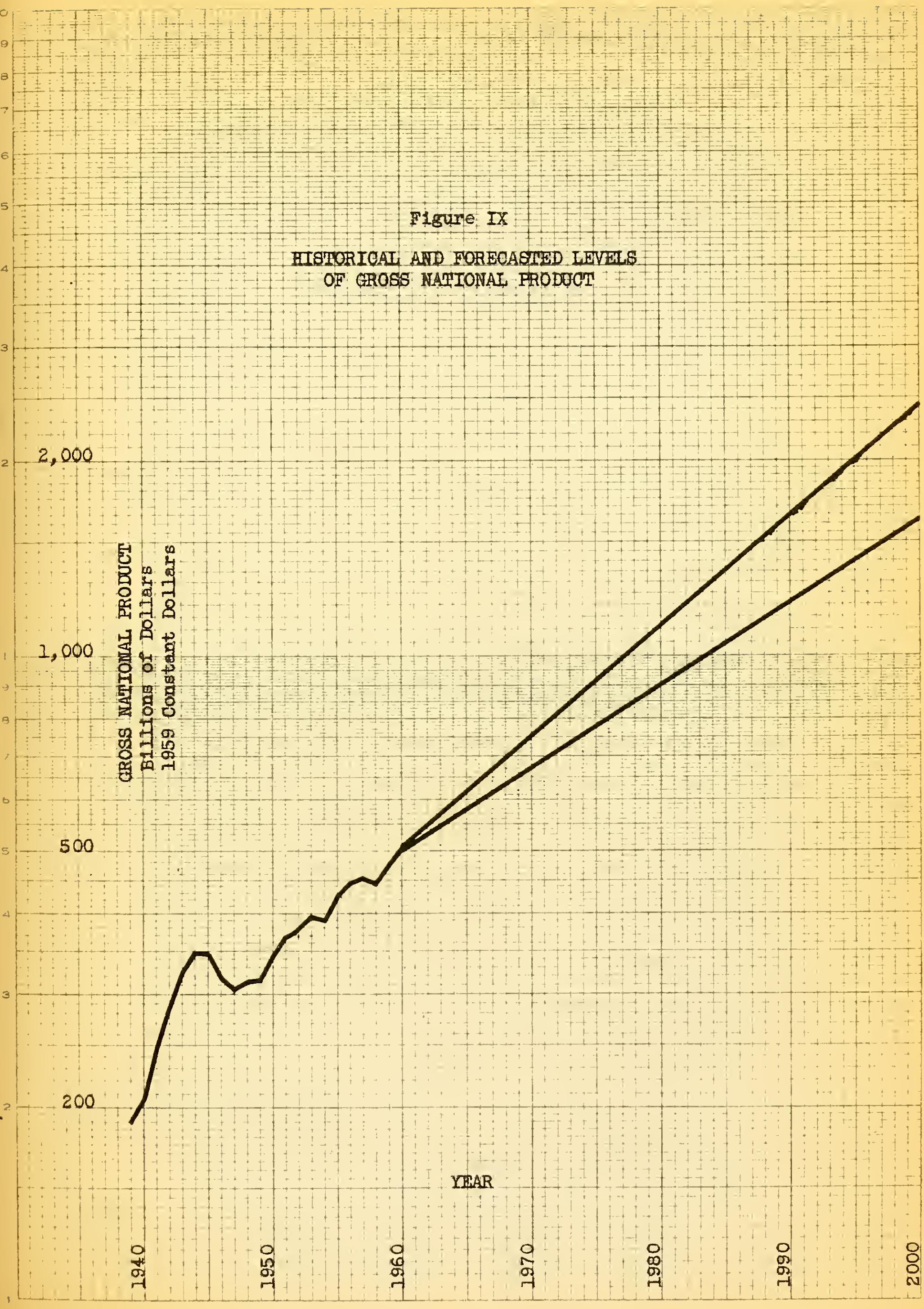

Figure IX

HISTORICAL AND FORECASTED LEVELS OF GROSS NATIONAL PRODUCT

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is a subject about which there seems to be little agreement especially among politicians. Historical analyses of the growth in GNP have been prepared by the National Industrial Conference Board and the U.S. Department of Commerce.* A trend analysis considering all years between 1887 and 1959 revealed that the average annual growth during the period was three percent. A trend analysis considering only the high level years between 1909 and 1957 indicated also an average annual growth in GNP of three percent. Figure IX indicates the Gross Product since 1939 and the levels of production forecast for the future.

While there is considerable interest in the possibility of accelerating the rate of growth of GNP, it seems that the long-run historical trend in growth of three percent might reasonably be considered as the minimum rate for the purpose of making long-range forecasts. However, it seems likely that governmental policy could be used to stimulate economic growth at a rate in the neighborhood of four percent annually without causing major disruptions.

A four percent rate of growth seems to be about as high a rate of growth ~~that~~ as could be sustained over a long period of time by a free enterprise economy. Independent forecasts of labor force correlated with a four percent growth rate in GNP indicate that worker productivity would have to rise faster than the observed long-run historical growth rate. However, the difference is not so excessive as to suggest that a four percent growth rate is unattainable over the long run. For the upper range forecast, a four percent growth rate was employed.

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* Business Record, Op. Cit., p.17.

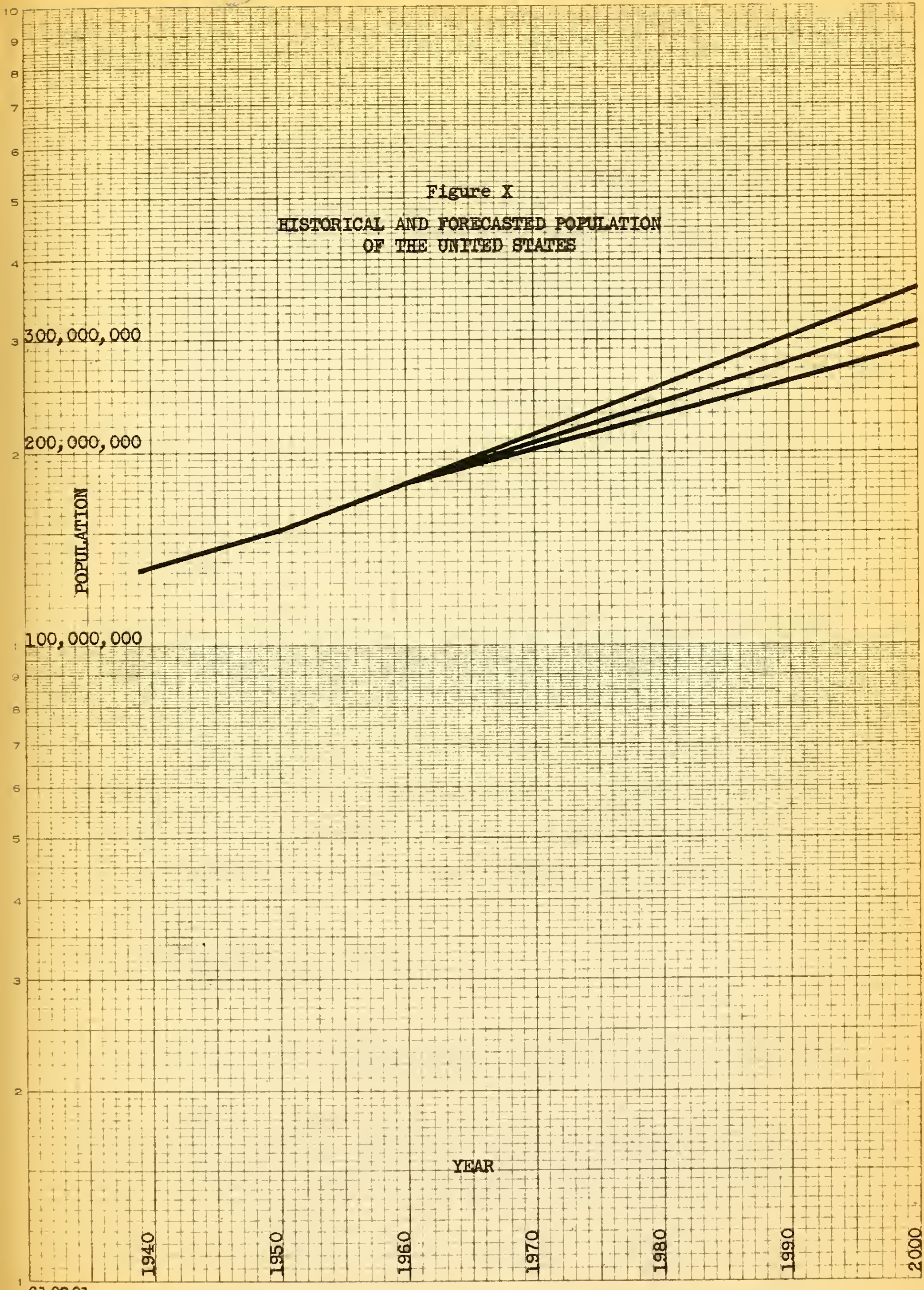


Figure X

HISTORICAL AND FORECASTED POPULATION OF THE UNITED STATES

Population and Labor Force

Underlying the Gross National Product Forecasts are asuumptions as to the growth rate of population and labor force. During the period from 1900 to 1955-57, the NPA analysis indicates that population grew at 1.4 percent annually while labor force increased at the rate of 1.6 percent annually. Analyses of the more recent period from 1946-48 to 1955-57, revealed that population grew at 1.7 percent while labor force grew at the rate of 1.3 percent.

In the preparation of GNP forecasts, rates varying from 1.3 to 1.7 percent were used for forecasting national population. The rates used for forecasting labor force varied over the same range. A high, medium, and low rate of growth of population was used in the forecasts described above. The annual rates of growth used in the three forecasts were 1.25, 1.48, and 1.75 percent annually. These correspond to the rates used by Fortune magazine, the U.S. Department of Labor, and SRI, and the NPA, respectively.*

The three population forecasts used in projecting GNP are approximately the same as the Series II, III, IV projections of population made by the U.S. Department of Commerce, Bureau of the Census.+ The different forecast series are based upon alternative fertility assumptions.#

---

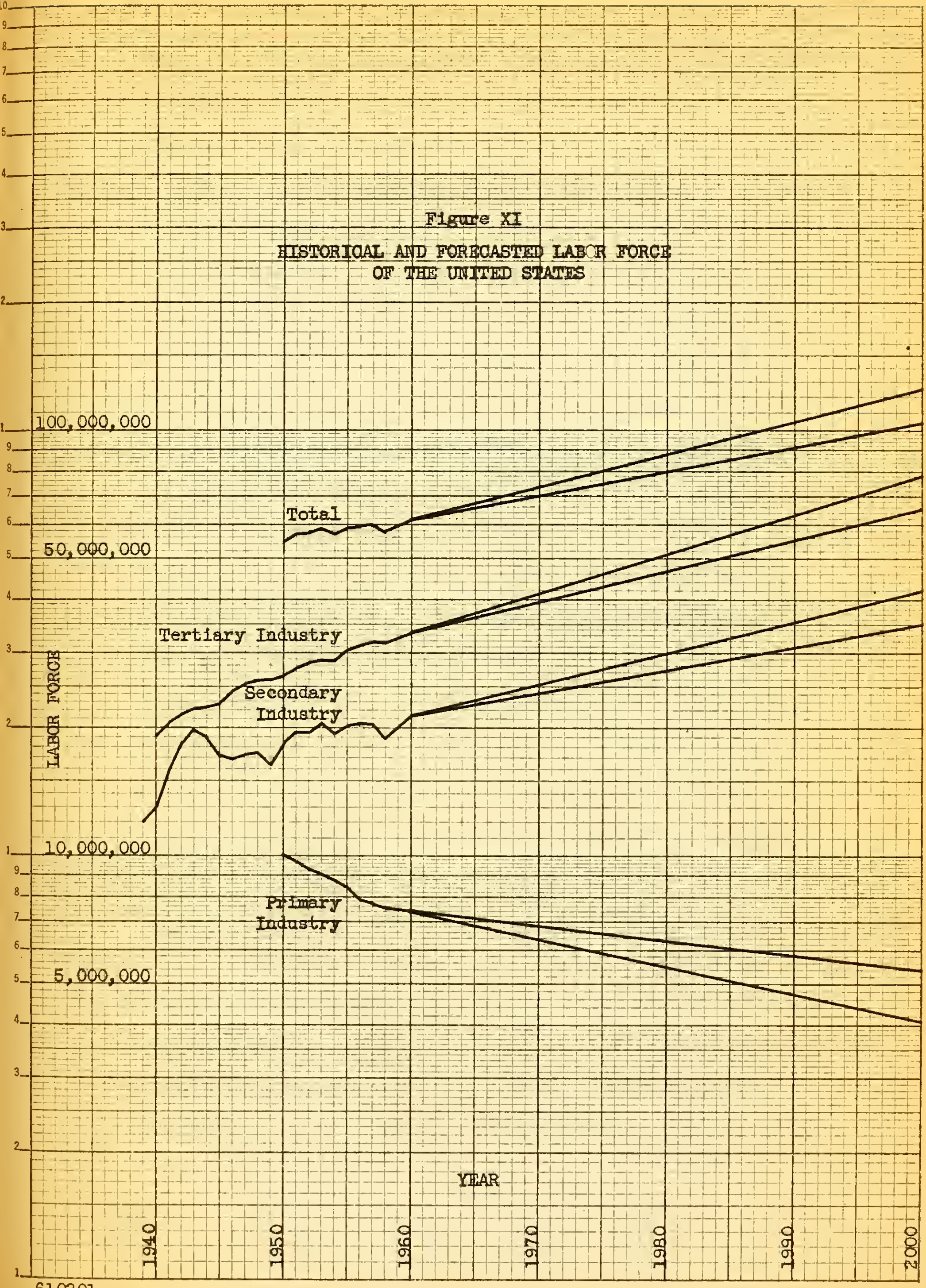
* Business Record, Op. Cit., p.18

+ Bureau of the Census, Current Population Reports, Population Estimates, Series P-25, No. 187, Washington, GPO, November 10, 1958.

# The fertility assumptions are as follows: Series II, same as the 1955-57 level to 1975-80; Series III, decline from 1955-57 level to 1949-51 level by 1965-70, then constant to 1975-80; Series IV, declines from 1955-57 level to 1942-44 level by 1965-70, then constant to 1975-80.

Figure XI

HISTORICAL AND FORECASTED LABOR FORCE OF THE UNITED STATES



The present population is about 179 million. The population in 1980 is projected at 228, 239, and 254 million by the three forecasts and by the year 2000, the forecasted population by the three forecasts would be 292, 320, and 360 million persons. The alternative forecasts are illustrated in Figure X.

Labor force predictions are based upon the forecasts of population to the extent that population is one factor affecting the size of the labor force. However, the definition of labor force used in this study indicates that there are other factors that would influence the number of persons in the labor force given a particular population.

The definition of labor force used in this study is that of the equivalent full-time average annual employment. This definition varies from the definition of the Bureau of the Census and the Department of Labor which issue employment statistics based upon the employment on a particular day or during a particular week.

While equivalent full-time average annual labor force is a function of population, it may be considered also as a function of the income level. During periods of prosperity, a higher proportion of the population have been observed to participate in the labor force than in times of recession and depression. Thus, rapid growth in income opportunities would be associated with high rates of participation. At the same time, as income grows, there is a tendency to take increased leisure time. This factor partially explains the long-run decline in the hours per work week.

In predicting labor force, the rate of growth of income was considered such that the participation of the population in the labor force

would be higher in times when income growth is rapid. Thus, for the three percent and four percent increase in GNP, the labor force forecasts for the former was lower than for the latter given any level of population. However, it is hypothesized that there would be a correlation between high rates of population growth and lower rates of participation. It was reasoned that when the rate of increase in population changes, the distribution of persons by age group undergo a shift because of the change in the number of persons coming into the early age groups.

Another factor influencing the participation rate is the propensity for secondary workers to enter the labor force. The observed trend of more women entering and staying in the labor force is assumed to occur in the future and this would cause a long-run increase in the overall participation rates.

Thus, the assumptions implicit in the predictions of labor force are:

1) SLIGHTLY RISING PARTICIPATION RATE FOR THE NATION.

An examination of the basic data in Appendix A will show that for any forecast of Gross National Product the rate of participation increases for all alternative forecasts except one. The participation rate increases from the present rate at from .02% to .13% per year for the four percent forecast and at between .C61% and a minus .046% annually for the three percent forecast of GNP. The negative change in the participation rate of reduction of the percentage of population in the labor force, indicates that the economy is not expanding fast enough to accomodate the labor force available because of rapidly expanding population.

*

Are these relationships applied thruout at the 40 yr. period?.. – After a while high pop. rate would also increase the particip. rate.

2) LOW PARTICIPATION RATES WITH HIGH POPULATION GROWTH RATES AND VICE VERSA.

Relatively high rates of growth in participation accompany low population growth rates in the three and the four percent annual growth forecasts of GNP with lower rates of growth in participation accompanying low growth in GNP. This may be seen in Table I.

TABLE I

CORRELATIONS BETWEEN THE ANNUAL GROWTH RATES OF POPULATION, PARTICIPATION AND PRODUCTIVITY*

Population	4% GNP Growth		3% GNP Growth	
	Participat'n	Productivity#	Participat'n	Productivity#
1.23%	0.13%	2.57%	0.061	1.692%
1.46%	0.079%	2.39%	0.015	1.497%
1.76%	0.02%	2.177%	-0.046	1.259%

3) HIGH RATES OF PARTICIPATION GROWTH ACCOMPANY HIGH RATES OF INCOME AND GROWTH

Table I shows that the growth in participation is higher in the 4% than in the 3% forecast. In addition, participation growth rates are higher in periods when productivity is growing most rapidly.

The alternative National labor force projections based upon these assumptions are shown in Figure XI.

---

[*] Applicable to forecasted information shown in Appendix A.

[#] The compensation for the declines in the work-week, assumed to decrease at .6% annually is included in the productivity figures. Thus, actual productivity growth rates are .6% higher.

Productivity

For the sake of simplicity, the net productivity of production factors (land, management, labor, capital) have been attributed to labor force. Management and labor are included in the labor force data used in the analysis and forecasts. However, the effect of changes in the productivity of land and capital must be considered exoginously. ?

By employing the concept of the production function, techniques for handling the affect of capital may be devised. The concept of the production function is that any given level of output may be achieved by many different combinations of labor and capital. Thus, a given output may be achieved by using large quantities of labor and little capital or by using small amounts of labor and large amounts of capital. An example of this would be the substitution of a large expensive machine for some of the labor force.

This relationship is embodied in the forecasts in that high rates of population growth are accompanied by low growth rates in productivity. This may be seen in Table I. A correlation between growth rate of population and the quantity of capital available for the labor force to work with was hypothesized. When population is growing rapidly, an increasing share of the national product must be devoted to consumption in order to maintain the per capita consumption levels. Thus, a relatively smaller amount is available for capital formation. The effect of sluggish capital formation would be a slow growth in net productivity. [illegible]

The actual growth in net worker productivity ranges between 2.19% and 2.59% annually for the 4% GNP growth forecast and from 1.27% to 1.7% annually for the 3% GNP growth forecast. It will be noted that

these figures are .6% higher than those shown in Table I which consider the effect of a declining work-week on net worker productivity.

Relationship Between Variables

The relationships between the variables of population, labor force, and productivity growth as sketched above may be viewed as a lever. On one side of the fulcrum is the rate of population growth balanced by the duet of participation rate and rate of change in productivity on the other side. As the rate of change of population decreases, the rate of change of productivity and/or the participation rate increases to establish a new equilibrium point. The determinent of the equilibrium point is the rate of change in Net National Product, a component of GNP.

In fact, this equilibrium does not exist. We have sags + spurts - not an equilibrium economy.

It will be seen from evaluating the relationships between the variables that the rate of change in Net National Production is the product of the rate of change in population and productivity times the rate of change of the participation rate. This equality exists because at any point in time the labor force times the productivity of labor equals the National Product. The difference between Net National Product and GNP is the value of depreciated capital goods; i.e. the capital consumed in the production of goods and services.

A Comparison Of Local And National Patterns

There are some important differences and similarities between National patterns and patterns within the Boston Metropolitan Area and the City of Boston. These differences and similarities can best be identified through an evaluation of the rates of change of the components of the economy, the metropolitan share of national components, and the composition of the metropolitan economy vis a vis the national economy.

Rates of Change

The important rates of change to consider in comparing the local and national economy are those of population, productivity and participation rate. It is generally known that there has been a net outmigration from the Boston Metropolitan Area during recent years. While the metropolitan area has had population increases since at least 1930, the number of births minus the deaths has been larger than the absolute population growth. The occurance of this phenomenon may be explained in part by the occupational and industrial transition that has been going on as the older industry, leather and textiles in particular, decline and new industries replace them.

The annual rate of growth of the metropolitan population is forecast to lag behind national population growth by from 23.9 to 29.5 percent. The low metropolitan growth rate is .95% compared with the low national rate of 1.23% annually, while the high rate for the metropolitan area is 1.42% compared with 1.76% for the nation.

The Boston Metropolitan Area is able to maintain its rate of growth in production despite slow growth of labor force primarily because of increases in participation rate and productivity. Because the metropolitan area is a highly urbanized region, the rate of participation of the population in the labor force is higher than that for the nation and ~~in~~ for other less urbanized portions of the country. In the forecasts, it was assumed that the characteristics of urbanization that contribute to high participation would continue (i.e., low birth rates, small families, high percentage of single persons, etc.).

The rate of change of productivity for the nation varies between 2.18 and 2.57 percent annually for the four percent GNP growth forecasts and between 1.26 and 1.69 for the three percent GNP growth forecast. At the same time, productivity for the Boston Metropolitan area is forecast at annual growth rates of between 2.18% to 2.58% and between 1.4% to 1.8% for the four and three percent GNP growth forecasts.

Thus, even though the population growth of the Boston Metropolitan area does lag considerably behind the growth rate in the nation, the growth rate of production, Gross Product, in the Boston area approaches the rate of growth of the nation because of equal or more rapid increases in productivity and increased participation of the population in the labor force.

Share

The consequences of differential rates of change is a change in the way the metropolitan area contributes to the production of the nation. With a local rate of growth in Gross Product somewhat lower than the

national rate, the Boston area's contribution to national production will decrease relative to the total even though the local economy is performing well. The major issue to be discussed here is at what rate is the relative decline occurring and to understand the reason for the decline.

parallel construction

With regard to total production, the Boston Metropolitan Area contributes at present about 1.6 percent of the total GNP. By the year 2000, the share is estimated at about 1.4 percent. The relative decline in share is about 10 percent over the forty-year period. This is the effect of a differential of about thirty-one one hundredths of one percentage point in the rates of growth of production.

However, with regard to population, the decline in relative share is greater. At present, the Boston Metropolitan area has about 1.4 percent of the total national population. While the metropolitan population is growing, its rate of growth is from .33 to .42 percentage points below the national rate. Over the course of forty years, the consequence of this rate differential would be that the metropolitan population is about 1.2 percent of the national population.

It might be assumed that the differentials between population and production growth between the nation and the metropolitan area in the long run will benefit the Boston Area. The benefit would be a more rapid increase in per capita production and per capita income. However, per capita income in the metropolitan area is now growing as fast as the national average. This is because of substantially lower rates of growth in participation within the metropolitan area. Growth rates in participation in the nation are almost three times as high as

those of the metropolitan area. As the participation of the population in the labor force increases, the number of people supported by each worker declines. This is occurring more rapidly on the average throughout the nation than it is in the Boston Area. Hence, other things being as they are, the Boston Area suffers a relative decline in the margin by which its per capita income exceeds the national average.

The present gross product per capita in the metropolitan area is 15.2% above GNP per capita, $3,250 vs. $2,820. By the year 2000, the differential rate of increase in participation will cause the Boston Area's margin to decline to 13.5%

Composition

The manner in which the economy of the Boston Metropolitan Area contributes to the national economy can in part be identified through an evaluation of the composition of the local economy vis a vis the national economy.

As a highly urbanized region, the local contribution of Primary Industry is relatively insignificant. Its importance is expected to decline because its growth is not as rapid as the other sectors of the economy. The Boston area has its fishing industry which may maintain its vitality because of the port facility and the location of the port relative to fishing grounds. However, what agricultural production there is in the metropolitan area is expected to contract.

The production of Primary Industry in the United States is forecast to grow at a relatively slow rate. Output of Primary Industry is expedited to about double in forty years. On the other hand, the output of other sectors of the economy are expected to quintuple over the

same period. Thus, Primary industry on a national level as well as on the local level is to contribute a declining share of the total value of production. The absolute growth in the Gross Product of Primary Industry is essentially the result of very rapid increases in worker productivity inasmuch as a decrease in labor force is forecast. The present labor force is about 12 percent of the total national labor force. By the year 2000, this percentage is expected to range between 3.5 and 4.7.

Relative to the total economy, the future nation wide contributions of Secondary Industry are expected to be slightly lower than they are at present because growth is forecasted at a rate slightly lower than that for the total national economy. The gross output of secondary industry was 39.4 percent of total GNP in 1960, and by the year 2000, it is expected to decline to between 39.1 and 37.2 percent. Thirty-four percent of the total national labor force is employed by Secondary Industry during 1960 although this is expected to decline to about one-third of total by 2000.

POOR
same amount

The Gross Product of Tertiary Industry is expected to increase most rapidly. In 1960 it comprised 57.5 percent of the GNP and in forty years it is expected to increase to about 60 percent. Rapid growth in Tertiary Industry Gross Product is caused by growth in employment which is high enough to more than offset the lower than average growth in worker productivity. During 1960, 53.9 percent of the total labor force was employed in Tertiary Industry. By the year 2000, this percentage is expected to increase to about 62.5 percent.

~~A~~ In brief description of the change in the composition of the

national economy is that there will be a shift away from Primary Industry towards Tertiary Industry. This shift is particularly significant in the employment pattern though noticeable also in the share of the GNP contributed by these Industries.

In the Boston Metropolitan Area, comparable but less pronounced shifting of patterns is forecasted. The shift in labor force from Secondary to Tertiary Industry is more significant. In 1960, 34% of the metropolitan labor force was employed in Secondary Industry. This is expected to decline to about 32% by the year 2000. The share of Gross Product produced by Secondary and Tertiary Industry, however, is not expected to change much at all due to unequal rates of growth of worker productivity.

LOCAL IMPACT OF EXTRAREGIONAL GROWTH

Because of the diversified character of the Boston Metropolitan Area economy, growth in demand for goods in other regions has an impact upon the income and production of the area. The impact of extraregional economic patterns and differential growth rates are discussed below.

Regional Economic Patterns

The study of the impact of extraregional patterns on the local economy is attempted by investigating the spatial-economic factors and the demand differentials between regions. The subject of spatial-economics includes a study of the relative friction of space on the economic interaction. The spatial concept is based upon the observation that space has an inverse relation to the amount of economic interaction between regions and that interaction between regions tends to increase when regional resources and production characteristics are unique and when regional incomes increase.

* How are these two taken into account in the gravity model?

HVD-MIT

Spatial Factors

A spatial concept was employed in analyzing and forecasting the economy of the Boston Metropolitan Area. The concept is that the amount of economic interaction between the Boston area and other regions is a direct function of the demand in the other regions as measured by regional income and an indirect function of the intervening distance.

Distance, per se, is not a meaningful variable to consider in measuring the potential for interregional interaction. A more meaningful

measurement would be the economic cost of overcoming the friction of space or the cost of transportation between regions. By this means interaction potential can be related to other economic factors such as the differential in freight rates between regions.

The measure used to evaluate economic influence of space on regional interaction is the cost of transporting a unit cargo between the regions. The exact measure used in this study is the cost of transporting by rail a 100 pound cargo of Class 100 freight between regions. They are listed in Table II.

Freight rates per mile usually decrease as the total distance over which goods are transported increases. The effect of this feature of the cost of transportation is that the marginal cost of transporting goods to more distant regions is small relative to the total cost. For example, from Boston, it will cost only 2.4 times as much to ship goods to San Francisco as it does to Chicago even though the distance in miles to San Francisco is 3.2 times that to Chicago.

In interpreting the data in Table II with regard to the affect of economic distance on economic interaction, it will be noted that the potential for interaction based upon distance only, between Boston and Chicago is 2.4 times as much as the potential for interaction with San Francisco. However, if the demand for goods as expressed in total income were 2.4 times as great in San Francisco than in Chicago, the net affect would be that the potentials for interaction are equal.

The relative potential for regional interaction considering both economic distance and extraregional incomes only will indicate the relative locational advantages of Boston and the other regions of the nation.

Table II

RELATIVE FREIGHT CHARGES FOR SHIPPING BY RAIL 100 POUNDS OF CLASS 100 FREIGHT BETWEEN REGIONS*

From Region	To Region								
	A	B	C	D	E	F	G	H	I
A	1	466	454	679	704	1106	234	286	286
B	466	1	408	455	608	856	480	509	509
C	454	408	1	501	469	832	476	496	496
D	679	455	501	1	472	626	702	717	717
E	704	608	469	472	1	523	748	763	763
F	1106	856	832	626	523	1	1174	1189	1189
G	234	480	476	702	748	1174	1	122	122
H	286	509	496	717	763	1189	122	1	12
I	286	509	496	717	763	1189	122	12	1

*Provided by the New Haven Railroad, Boston.

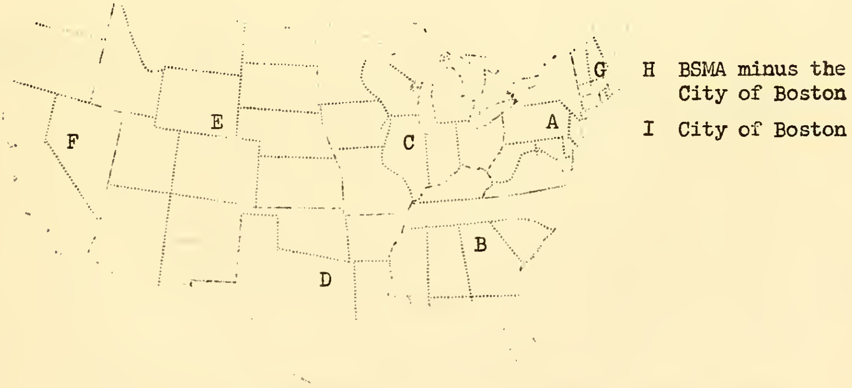


Figure XII

REGIONAL SUBDIVISION OF THE CONTINENTAL UNITED STATES

Resource Differentiation

The measurement of the potential for economic interaction between regions based upon only the economic distance between them as described above omits the effect of regional resource differences. Regions having unique climate and physical plant may capitalize on these unique resources and produce goods which are not and cannot be produced everywhere. If the demand for these goods is ubiquitous, then the region would have markets throughout the nation and would interact economically with distant regions. Oranges grown in California and marketed in New York ~~is~~ are a good example of this. On the other hand, the resource characteristics of some regions may not be unique and the market for the goods produced may be (considerably) local; that is, limited to neighboring areas.

Thus, a satisfactory measure of the potential for interaction among regions should reflect the different resource characteristics of the regions of the nation.

Spatial-Resource Affect

It is the combination of distance between regions and the uniqueness of the regional resources which reflect economic interaction. In the methodology employed in this study, the economic distances are correlated with statistically derived factors to adjust the economic distance. More about why and how this is accomplished is presented in Part III.

? describing uniqueness?

The Boston Metropolitan Area is an interesting case to select

for discussing the combined affect of space and resources. The location of the Boston Metropolitan Area relative to the other regions of the nation judging by its distance to other regions suggests a poor location position. However, many of the products and services produced locally are purchased by individuals and businesses in other regions. The local electronics and education industry are examples of this. The urban character and the intense concentration of production facilities in the Boston Metropolitan Area suggest that many of its markets lie outside of the area. It was found, as might be expected, that the resource factor for the BSMA indicated more interaction with other regions than any other region of the nation.

* Due to the size of the region vis a vis other regions

The rate of growth of the Boston Metropolitan Area of Gross Product is a composite of growth due to increases in labor force and the net productivity of labor as well as of growth in the potential of extra regional interaction. The growth rate of production due to growth patterns within the region where local products are consumed, is in excess of the growth rate in total production and the growth rate due to labor force and productivity increases. Thus, these findings indicate a strengthening of the Boston economy because of increased income and demand in the other regions of the nation.

Confused
It says grwth due to local is higher than grwth due to outside

Extraregional Growth

The growth patterns in other regions of the nation must be understood to evaluate the relative strength of the local economy as a result of these patterns. Over the long-run, the major issue is the extent to which the local economy can capitalize on national growth.

Right

[illegible]

[illegible]

[illegible]

[illegible]

Shifting of Dominance

The forecasted economic pattern indicates a relative shifting of economic dominance. The growth rate of Gross Product in the Boston Metropolitan Area is the lowest of all of the regions considered in the study and by and large, the lowest rates of economic growth occur in the regions in the northeastern portion of the country. Except for the southeastern United States, these regions whose growth rate is higher than the national ~~rate~~ are located west of the Mississippi. There is indicated a trend towards a shifting of the national center of economic activity away from the Boston Area. Thus, Boston is somewhat handicapped by not being near to the regions of greatest economic growth. However, the unique resources of the Boston area and a sustained effort to develop a local environment that is efficient and amenable will enable local producers to compete effectively in distant markets.

Table III

LIST OF REGIONS ASSEMBLED IN RANK ORDER BY RATE OF GROWTH IN GROSS PRODUCT

Name of Region	Region Code Letter	Rate of Regional Growth: 3% GNP Growth	Rate of Regional Growth: 4% GNP Growth
Far West Region	F	3.395%	4.383%
Southeast Region	B	3.324%	4.307%
Mountain Region	E	3.316%	4.283%
United States	J	3.000%	4.000%
Gulf Region	D	3.008%	3.971%
Lakes Region	C	2.856%	3.879%
Northeast Region	G	2.835%	3.851%
Atlantic Region	A	2.772%	3.771%
BOSTON METROPOLITAN AREA	H+I	2.689%	3.675%

* ?

transfer payments?

due to size?
because its tertiary?

would other met areas also come out low? — Otherwise, I would think a met area would average higher than a region.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Contributions to Boston's Economy

In conclusion to the discussion of the impact of extraregional growth on the Boston Area's economy, it is worthwhile to consider the quantative impact of variations in extraregional growth.

The gross production Far West region of the country, Region F, see Table III, is expected to grow at about 4.4%per year. This growth pattern is a consequence of population and productivity growth as well as the improvement of its spatial position relative to other regions. The Far West Region is furthest away from the Boston area and it might be expected that the effect of this region on the Boston area economy would be small. However, if the production of the Far West Region grows only at 3.4%,one percentage point less, by the year 2000, the annual loss to the Boston Area would amount to about $50,000,000 in output.

Converted into jobs and population, this would mean that there would be about 3000 fewer jobs and perhaps 10,000 fewer persons living in the area. This example, while hypothetical, does point out the stake that the local economy has in national growth. In Part II more will be presented on the need for good local planning and housekeeping.

Part II

IMPLICATIONS OF THE FINDINGS

Section A: FORECASTS AND FORECASTING: THEIR ROLE AND VALUE

The simplest method of forecasting involves the extrapolation of historical trends for the purpose of estimating future economic activity. As such, forecasts obtained in this manner do not predict what will happen. Rather, such a forecast can indicate only what the future would be if the factors that induced change in the past continued to induce change in about the same way.

Experience has pointed out that historical trends do not continue necessarily ~~on~~ into the future and that economic history need not always repeat itself over long periods of time. Thus, the accuracy of a prediction is dependent upon how well the forces that produce change in the future have been identified, evaluated, and related.

The Role of Forecasts

Basically, economic forecasts are a current estimate of the future based upon the information on hand. As new information ~~becomes available that~~ points up inaccuracies in the assumptions and values used, new forecasts should be prepared based upon the latest information. Ideally, forecasts should be kept up-to-date by revising them on a more or less continuing basis.

Best estimates of the long-run and short-run future are needed by planners and decision makers in public and private enterprise. Some idea of what the future might be is necessary as the basis for action to be taken today.

The Role of Community Objectives

Economic forecasts as presented here do not represent what will happen so much as what may happen if the basic assumptions underlying the forecasts are correct. Forecasts should not be considered as unalterable courses of events. To some extent, the community does have control over what will happen.

What happens ultimately is a combination of internal and external factors. Many of the internal factors are controlable and certainly may be influenced by the aggregate action of the community and its government. The community does have the opportunity to formulate its own objectives and the programs for achieving them, and does have the opportunity to choose how ~~they are~~ to allocate ~~their~~ its resources.

Thus, while the community usually cannot exercise much influence over factors in other regions of the country and while these factors often determine local choices, there is an area within which the community can determine for itself what the future is to be. To exercise this influence, the community must first identify its objectives and then formulate effective programs for achieving them.

Objectives and Forecasts

Ideally, the processes of forecasting, goal formulation and programming should occur concurrently and on a continuing basis.

Basic to any action is the identification of the objectives of the action. The identification of community goals is a prerequisite

to preparing programs for achieving them. Once goals have been established a number of programs and program alternatives can be outlined. Forecasts and the forecasting process may be employed to evaluate community goals and program~~s~~ forecasts. The forecasting process may be used also to evaluate the details and the potential effectiveness of community programs by varying the appropriate assumptions underlying the forecasts.

? sense

The forecasting method used in this manner becomes important as a tool for developing community programs. The forecasts become less important per se. Rather, the forecasts are important as indicators of the possible effects of one program alternative vis a vis others. By placing more emphasis on the forecasting method as a tool rather than the forecasts themselves, planners and decision makers can begin to determine, prior to implementation, which of the many program alternatives would be most effective in achieving their goals.

Section B: POLICY IMPLICATIONS

Implicit in the economic forecasts are the assumptions that the Boston Metropolitan Area will be able to maintain and enhance its relative advantage and meet effectively competition from other production centers throughout the nation. These assumptions touch on major policy issues which should be identified.

Perhaps the most important implication is that an efficient, convenient and amenable local physical environment will be established through the coordination of improvements made by public and private enterprise and through the regulatory powers and inducements of the local governments. This implies the minimization of congestion and delays in the circulation system, the development of a land use pattern that will minimize travel and the development of an efficient amenable and convenient environment. By doing this, Boston business can maintain and enhance its competitive advantage.

The environment must be amenable for living and playing as well as for business and industry; it must be amenable for carrying out the non-economic aspects of life. Not only should the communities of the metropolitan area be good places to live, in that the physical quality of the buildings is well above standard and the communities are well laid out, but they must be well served by recreation facilities, good school systems, libraries, hospitals, etc. Basically, the implication is that the community and ~~their~~ its government will be able to

[illegible]

[illegible]

[illegible]

[illegible]

develop the full potential of their physical resources and capitalize upon the advantages inherent in urbanization.

The relative competitive position of the Boston Metropolitan Area depends also upon its social and economic characteristics and their development. The renewal of physical plant and equipment by the business and industry of the metropolitan area is essential to maintaining a respectable rate of growth in productivity. Much of the plant and equipment is becoming obsolete, and if new investment is not forthcoming, worker productivity growth would be sluggish and the Boston Area's competitive position would be weakened.

The education and the development of skills of the area's labor force also is important for maintaining an adequate growth in productivity. The level of intelligence of the labor force and their manual and mental skills are very much dependent upon the quality of the education system as measured by the ability of the faculty and the scope of instruction offered. The recent announcement of Northeastern University's course for policemen leading to a bachelors degree in law enforcement is ~~but~~ ~~one~~ an excellent example of a program for increasing the skills of the labor force.

Finally, the forecasts imply that the metropolitan community will identify those types of business and industry that can thrive in the area and initiate programs for attracting them and providing sites where they may locate. An agressive program for attracting new business will be necessary to offset the declines in some sectors of the local economy and to maintain a high level of growth in the total economy.

Part III

THE DESIGN OF THE RESEARCH: A MODEL OF THE NATIONAL ECONOMY

Section A: THE RESEARCH CONCEPT

Analyzing and forecasting economic activity for a community has always posed many problems which are caused by the complexities of the economy and by our inability to forsee future events. Yet, the need for economic analyses and forecasts to gain a better understnading of the operation of the economy as a basis for decision making and planning constitutes a challenge to develop techniques that best satisfy this need.

The challenge of developing suitable economic analysis and forecasting techniques for the Boston Metropolitan area was especially great because of the unique characteristics of the region; that is, its location in the nation, its diversified economy, its unique resources and its size. The following criteria were established as guides for the selection of a suitable analysis and forecasting method.

> The method should relate the local economy to national economic patterns since the size of the region and the diversity of its economy suggest that its future will depend upon the course of the national economy.
>
> The method should consider explicitly in an integrated fashion, the area's potential in terms of the resources and the urban qualities that characterize the Boston Metropolitan Area.
>
> The method should permit the local economy to be evaluated in terms of its spatial relation to other regions of the nation since the transportation of goods to and from the area is a key factor in the operation of the local economy.
>
> The method should allow for the comprehensive treatment of the local economy since its diversified qualities indicate that the economic prospects of the area cannot be understood by considering separate industries as would be the case in areas like Detroit, where one or two industries dominate the economy.

[illegible]

[illegible]

[illegible]

> [illegible]

> [illegible]

> [illegible]

> [illegible]

The search for a suitable method among the tested techniques failed to yield a methodology which met these criteria exactly. The "Basic-Service" technique falls short of meeting these criteria because it spotlights a few industries as generators of economic activity and makes all other industry dependent upon their health. "Input-Output" analysis is currently considered the most advanced econometric technique. Yet, despite the laudable applications of this technique in Chicago, St. Louis, and Kalamazoo, it does not consider the effect of the spatial distribution of resources and economic activity or the shifts of relationships over time. . . . How does this take these into account?

is it not a gravity model like this one

The search for a suitable method among proposed untested, theoretical techniques, yielded one which met the established criteria almost exactly. The method was described first in 1954 in a publication by the National Bureau of Economic Research dealing with long range economic projection,* however, the first application of the method is in this study.

The method is based upon the use of an analogy of the economy wherein the relationships in time and space are established through mathematical methods. The method is sufficiently flexible to allow for the satisfying of the established criteria. The two most important features of the method are the opportunity to consider the affect of the spatial distribution of economic activity throughout the nation and the opportunity to consider the relative importance of resource differentials between regions of the nation.

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*Walter Isard and Guy Freutel, "Regional and National Product Projections and their Interrelations", National Bureau of Economic Research, Long Range Economic Projection, Studies in Income and Wealth, Vol. 16, Princeton, Princeton University Press, 1954, pp. 427-471.

[illegible]

[illegible]

[illegible]

[illegible]

THE STRUCTURE OF THE NATIONAL ECONOMY

The national economy is viewed in this study as a space-economy in contrast to the non-spatial conception of the Walrasian and Keynesian tradition. The spatial conception considers the phenomenon of resource flows from place to place as they pass through the transformation process to ultimate consumption. At any given point in time, given the existing distribution of resources and the existing techniques of transportation and communication, specialization and division of labor take place with regard to function as well as location. Errors in analyses and forecasts may be considerable if this web of interdependencies is not considered.

The spatial conception of the economy implies the concept of the region based upon the distribution of resources, the specialization and division of labor and other internal structural factors. The spatial conception of the economy presumes a number of regional economies consuming and producing goods and services and a web of interdependencies between them. The nature of the interdependence may be considered as markets for goods produced and as sources for goods required.

* How do you regester changes in the relation betw. regions - e.g. a Thruway

National Production; its Meaning and Components

National production may be considered from two viewpoints. On one hand, it may be considered as the value of the goods and services produced or consumed within a specific geographical area.

This approach to defining national production is known as the Flow of Product approach. National production is defined as the sum of the dollars spent by consumers for the goods and services produced by business and industry.

On the other hand, national production may be considered as the value of the productive services employed in the production of the goods and services. This approach is known as the Earnings and Income approach. National production is the sum of dollars paid out in wages, interest, rents, and profit; that is, the costs of production. Thus, on one hand, national production may be considered as a flow of goods and services and a reverse flow of dollars paid for them. On the other hand, it may be considered as a flow of productive services from labor, land, and capital and a reverse flow of dollars paid for their use.

Gross National Product

Gross National Product is the common measure of national production. It is the total value of the goods and services produced in a year before deductions for the value of capital goods consumed in their production. As such, it represents the results of the efforts of labor and capital in the production of these goods and services. The basic relationship used in this study is that Gross National Product is equal to the amount of labor used in production times the average amount of the value of the goods produced by each worker. The relationship may be viewed as an equality with output (value of production) on one side and input in the form of labor and effort value of goods on the other.

Input and Output

Gross National Product is used in this study as a measure of economic output -- the value of the goods and services produced. The basic inputs required for production are identified in classical economics as labor, capital, and land. Each factor is necessary and contributes to the production of the goods and services. The contribution of these factors to production is considered as their productivity --- that is the value of the goods produced per unit of input.

In this study the productivity of land and capital are not considered separately, rather they are attributed to the efforts of labor and considered as the productivity of labor. This amalgamation of productivity may be justified because it is labor and the efforts of labor that causes land and capital to be productive. Thus, productivity is defined as the net value of the goods and services produced per unit of labor employed.

*
How do you
account for huge
variations in
capital or ld. -
e.g. resource de-
pletion or new ?
resource (salt water).
Labor productvty.
very little in ep.
Or capital
flow between
regions?

For the purposes of this study, the unit of labor input has been defined as a worker working full time for one year. Thus, the definition of labor force is the average annual equivalent full time labor force.

Average annual equivalent full time labor force times net productivity of labor is equal to the net production of goods and services. Net production differs from gross production by an amount equal to the value of the capital goods consumed in the process of production; that is, depreciation.

[illegible]

[illegible]

[illegible]

[illegible]

Production and Growth

The content of this study is primarily concerned with production in that it seeks to forecast future levels of production. The study does not specifically consider consumption and investment or the demand for the goods and services by the public and by government. While the methodology employed in the study does not consider these specifically, they are of basic importance in the functioning of the economy.

Investment

The importance of levels of investment in the determination of income and employment is well delineated in Keynesian economic theory. The importance of investment expenditures lie in their multiplier effect on the total output. High investment is associated with high rates of economic growth. While investment levels are not considered specifically in this study, many economic forecasts are based upon levels of future investment. The economic forecasts of the National Planning Association* which are based on a 4.2% rate of growth in GNP as compared with our 4.0% note the following with regard to investment.

> However, a change in the rate of excess capacity needed for a continued smooth functioning of the economy could have a significant effect on total output and the relationships among capital, labor, and output. As determined from its capital expansion surveys, McGraw-Hill estimates that under current conditions the "preferred" level of

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*National Planning Association, Long Range Projections for Economic Growth, The American Economy in 1970, A Staff Report, Planning Pamphlet No. 107, Washington, NPA, Oct. 1950

operation in manufacturing is 90 percent of full capacity. If we suppose, as a hypothetical illustration, that by 1970, the preferred rate for the economy as a whole, would fall to 85 percent, the ratios of capital stock to labor, and capital stock to output, would be some 5 percent higher. This is assuming the unlikely case that the number of employees or man-hours would not be affected by the capacity change. In this situation, an additional investemnt of $50 billion would be required between now and 1970 to achieve the 1970 projection of output. If this additional investment is not forthcoming, and there is no change in the projected number of employees, the ratio of output to labor will be 5 percent less, and the 1970 GNP will be almost $40 billion less than projected.*

Government

The affect of government action on the economy, while not always well understood is widely known to be considerable. Direct government influence stems from the tax power which implies the power to collect money as well as the power to spend it. While revenue is collected and disbursed for the purpose of rendering specific services to the people and businesses of the nation, it has been desirable and necessary for government to use its power to maintain a balanced economy by correcting the imbalance created by the normal operation of market forces.

While this study does not consider government action explicitly, it does assume that Federal, state and local government will cooperate in policies designed to maintain the workable balance of the economy as a whole. We have assumed that the various levels of government will provide on an increasing scale, the many services without which industrial growth would be hampered -- such as resource development, aids to transportation, urban renewal, public education, research and training, and public health. It is expected also that public demand will

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*Ibid., p. 50.

cause a continued growth of these services at a rate even faster than the GNP growth which will be financed primarily from tax revenues. Whether taxes must be increased or reduced will depend largely on ~~what happens to~~ the magnitude of defense expenditures in relation to the GNP.

Private Consumption

The third component of GNP is private consumption expenditures. These make up about two-thirds of the total GNP. It includes expenditures for the purchase of goods and services by both families and non-profit institutions from the business or service sector of the economy -- mostly retail trade.

The amount and composition of private consumption expenditures are expected to vary in the future in accordance with changes in the composition of the population, average family income and/size, commodity prices, availability of consumer credit, amount of leisure time, and new product development. Historically, the National Planning Association found the following:

> In view of the dynamics of the consumer market, it may be somewhat surprising to find that these dozen expenditure groups tend to change in a fairly constant relation to one another. Part of the explanation is that changes in consumer expenditure habits primarily relate to specific commodities and services whose effects offset each other within the movements of the dozen broader aggregates with which we are working. For example, while we found the proportion of expenditure devoted to manufacturing commodities to be fairly stable, we also found that this did not hold separately for durable, nondurable and processed food expenditures. We would expect still greater variation in the relationship between such specific commodities as television sets and apparel.*

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* *Ibid.*, p. 45

In this study, private consumption has not been treated explicitly although in the development of the forecasts, the relationship between per capita income, population and productivity growth, and the growth of GNP is considered. The handling of consumption expenditures by the private and government sectors of the market, as well as investment expenditures, is implicit in the procedure. The subdivision of the productive components of the economy, which is the main emphasis of the study, is sufficiently gross to allow this.

THE COMPONENTS OF NATIONAL PRODUCTION

The explicit consideration of demand for goods and services, as noted in the findings of the ~~NPA~~ N.P.A., is more necessary as the categories of industrial output of the national economy are more finely subdivided. Thus, if economic forecasts of specific commodities were prepared, their relationship to indicators of demand would have to be clear. However, when economic output is subdivided in gross terms, as is done in this study, the minute shifts in demand and the substitutions of goods and services tend to offset one another. When gross aggregations of output are used, the relation to demand may be more general.

In this study, demand is considered explicitly through the concept of income potential, which is based upon the spatial distribution of purchasing power. The importance of the spatial aspect of the economy and the aggregations used in the analyses and forecasts will be discussed below.

Economic Activity Sectors

For the purpose of this study, the output of the economy has been subdivided according to Colin Clark's conceptual classification of all forms of economic activity. The classification is based upon the idea that all forms of economic activity may be viewed as falling into one of three categories. The first includes all activities that are involved with the extraction of raw materials for future processing. These activities are termed Primary Industry. The second includes those activities which process these materials into intermediate and final products. They are termed Secondary Industry. The third category is the remainder and include those activities which provide services to businesses, government, and households. They are termed Tertiary Industry.

Primary Industry

Basic to the entire process of production and the operation of the economy is the extraction from the land those raw materials required to produce the goods required by the rest of the economy. Agriculture, Forestry, and Fisheries naturally fall into this category of Industry and are the only industry considered in this group for the purposes of this study. While Mining also could be considered as a Primary Industry, it was not included in this category because of data problems. Mining industry was considered as a Secondary Industry.

Secondary Industry

Besides Mining, whose inclusion here may be argued, the category

of Secondary Industry includes Construction and Manufacturing. Both of these are activities which engage in the processing of the raw materials and their ultimate conversion into products that are used by businesses and households. Not included in this category are the industry which market and transport the intermediate and final goods. These are considered as services and are included in the Tertiary Industry category.

Tertiary Industry

In addition to Transportation and Wholesale and Retail Trade, the category of Tertiary Industry includes Government, Services, Communications and Public Utilities, Finance, Insurance and Real Estate, and other industry. The general characteristics which unite these industries into this category are that they are not concerned with production in the sense that they produce a product. Rather, these industries are concerned with the rendering of services, whether to business, government, or households, in the form of marketing, communication, transportation, or governmental services.

The Spatial Arrangement of Activity Sectors

It has been demonstrated that the growth or decline of production in any particular area or region of the country is not independent of the direction and the rate of change ~~of the change~~ of the production in other regions of the country.

The excellent study by E. L. Ullman of the geographic patterns of commodity flows* illustrate well the degree of economic interdependence of the regions of the nation, ~~and the degree of this economic interdependence.~~ Ullman's study of the destinations of all types of products shipped from the state of Washington indicates that Washington has trade relations with many states and that its market is national in character. By contrast, his study indicates that the spatial extent of the market for goods produced in Connecticut is much more limited.

There is no way of explaining this contrast inasmuch as the data is aggregated into "all commodities." However, if the data were plotted by commodity, the reasons for this variation may be identified. Ullman"s charts for shipments of products of mines and shipments of manufactured products originating in Iowa illustrate the difference in the transport characteristics of specific commodities. In a commentary on this, Isard notes:

> The shipments of products of mines terminate for the most part within the state, and fall off very rapidly with distance. This is a characteristic of mine product shipments of all states and is a reflection on the high weight, low value, per ton, and the ubiquitous nature of many products of mines. In contrast, the flows of manufactured goods from Iowa, fall off less sharply with distance. Were the data in dollar value, the contrast would persist.+

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*E. L. Ullman, et al., Maps of State-to-State Rail Freight Movement, for 13 states of the United States in 1948, Mimeographed, 1951, as cited in Isard and Freutel, Op. Cit., pp. 440-445.

+Isard and Freutel, Op. Cit., p. 466.

Ullman's data indicates also that there are differences among regions in the flow characteristics of the same commodity. In commenting on Ullman's data for shipments of agricultural products from Texas and California, Isard notes:

> Texas represents the typical pattern of agricultural commodity flows. These flows are usually concentrated within short distances; relatively few cover long distances. In contrast, are the much larger national flows of California agricultural products. They are a reflection of California's unique resources for fruit and vegetable production. The nature of Washington's "all commodity" flows can likewise be understood only in the light of its particular resource structure, its distance relations with other regions and their particular resource structure.*

Thus, the interdependence of regional economies is quite clear, ~~and~~ ~~that~~ the nature of this interdependence is related to the resource structures, the distance between the regions and the rate of growth of production. The implications of this observation on the method used in this study will now be discussed.

A SPACE ECONOMY

The methodology employed in this study was selected because it permitted the evaluation of the local economy in space relative to the economies outside ~~of~~ the Boston Metropolitan area. At the same time, it permitted the consideration of the unique resources of the metropolitan area. Having indicated above, the desirability of evaluating these relationships, at this juncture they will be discussed in terms of how they were handled in carrying out the study.

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*_Ibid._, p. 447.

Resources, Production and Markets

The web of interdependencies which are to be evaluated and considered in the process of preparing the economic forecasts results from the uneven distribution of units of production, resources and markets throughout the nation. The discussion of the structural variations that occur in the economy of the different portions of the nation in a general way is presented prior to the description of the operational elements of the study.

Structural Variations

Structural variations, the imbalance in the distribution of economic factors, are the reasons underlying the establishment of an interregional economic web. Among the important specific imbalances are the type and extent of regional specialization, the imbalance in the type and amount of regional resources, the differential regional locational advantages in terms of markets, transportation facilities rates, and the differential patterns of growth not only in economic terms but in terms of social factors as well.

If the social, economic, physical, and resource composition of each region were identical, there would probably be a minimum of trade between regions. By and large, each region would tend to be self sufficient. Because production would be ubiquitous there would be only a small probability of finding markets in other regions for goods produced in any particular region. As a result, each regional economy would attain approximately the same level of specialization, with variations related to the size of the local market.

In reality, however, this is not the case. Due to imbalances in locational advantage, accessibility, resources, etc., it is desirable for regions to specialize often to a high degree. Detroit is the main center for the production of automobiles because of its relation to resources and markets and the patterns of transportation facilities. California, because of its climate and quality of soil, supplies a national market for some agricultural products and derivative products, such as wine. These are but some illustrations of the way in which specialization and its advantages creates a dependence of the local economy upon the remainder of the nation. The greater the extent and the higher the level of specialization, the greater is the dependence of a regional economy upon the economy of the remainder of the nation.

The equal distribution of resources and markets and the subsequent imbalance of specialization as well as intended and unintended discrimination with regard to transportation rates and facilities creates a marginal potential for growth at the expense of other areas without this advantage.

The differential patterns of growth and decline resulting from social and economic forces, a continually shifting of dominance and the destruction of equilibrium, stimulates new interdependencies and reduces the importance of old ones. Differential patterns of growth in income and in population ultimately result in the shifting of markets, the degree of specialization and the alteration in the relative locational advantages.

Not only is there a web of interdependencies between regional economies that must be evaluated and identified but this web is constantly shifting and changing. Thus, in the preparation of economic

analyses and forecasts for the Boston area, it is important to consider the spatial aspects of economic interaction and to measure the impact of shifts of markets and resources.

Urbanism

The web of interdependencies between economic units of a whole logically becomes more complex as the whole is subdivided into a larger number of units. The greatest complexity of interregional interdependencies exist between relatively small urban complexes, such as the Boston Metropolitan area and the rest of the nation. ~~Yet,~~ Still more complex is the interdependence between the City of Boston and the rest of the metropolitan area and the rest of the nation.

The complexity of the economic interdependencies arises from the phenomenon of the urban complex as a production center. The amount of goods produced there is greater than the amount that can be consumed by the local population and businesses. Thus, urban centers depend upon external markets for their excess production. They depend also upon external sources for some of the goods required for local production and private comsumption because of regional differentials in resources and specialization.

Urban complexes differ greatly from regions of larger size in their economic character. On one hand, urban centers tend to have little Primary Industry as compared with larger regions which include urban complexes along with the great spaces between them. On the other hand, urban complexes ~~then~~ tend to have a higher proportion of their total output produced by Tertiary Industry. This in part explains why urban

Table IV

REGIONAL DEFINITIONS USED IN THE STUDY

Code	Region	State
A	Atlantic	Connecticut
		Delaware
		Maryland
		New York
		New Jersey
		Pennsylvania
		Virginia
		West Virginia
B	Southeast	Alabama
		Florida
		Georgia
		Kentucky
		Mississippi
		North Carolina
		South Carolina
		Tennessee
C	Lakes	Illinois
		Indiana
		Iowa
		Michigan
		Minnesota
		Missouri
		Ohio
		Wisconsin
D	Gulf	Arkansas
		Louisiana
		Oklahoma
		Texas
E	Central	Arizona
		Colorado
		Idaho
		Kansas
		Montana
		Nebraska
		New Mexico
		North Dakota
		South Dakota
		Utah
		Wyoming
F	Far West	California
		Nevada
		Oregon
		Washington
G	Northeast	Massachusetts except BSMA
		Maine
		New Hampshire
		Rhode Island
		Vermont
H	Boston Metropolitan Area minus the City of Boston	
I	The City of Boston	
J	United States	

complexes depend upon a hinterland for food while the hinterland depends upon the urban areas for services. For the purposes of evaluating these and other interdependencies on an operational level, the nation must be subidvided into geographical areas.

The Region as an Economic Unit

The preparation of economic forecasts and the carrying out of economic analyses presupposes a delineation of geographical areas to which the findings relate. The concept of a region and the subsequent delineation of regions relate directly to the purposes for which the delineations are made; in this case, for the development of economic analyses and forecasts for the Boston Metropolitan area.

Concept of the Region

An analytic description of economic reality distingusihes components by location as well as activity sectors. Just as the term "activity sector" is used to sum components sharing similar characteristics, the term "region" is used to sum components contiguous in space. The purpose of delineating regions is for the convenient collection and organization of information required for the study and to permit the evaluation of the economy in space.

A region may be viewed as a hierarchy of subdivisions ranging from one or more "core areas" to marginal areas beyond. For this study, regional delineations are based upon the existance or grouping of major

urban concentrations and the areas they dominate. The delineation of the regions of the continental United States based upon this conception of a region is shown in Figure XII and Table IV.

It is recognized that National regions are impermanent and fluid, with respect to time due to the operation of social and economic forces. However, in carrying out this study, the regional delineations were assumed to be as appropriate in the future as they are in 1960. If the changes in the region are confined to the internal arrangement of regional elements, the overall patterns of regions need not be altered. If, however, there is a shifting of dominance of the way in which the spatial economy functions with regard to urban agglomerations, it is likely that the regional delineations would be affected.

* How will this affect the interaction-impact data?

Section B: THE MODEL OF THE ECONOMY

The material presented above will form a background for the following development of the methodology employed in the study. The method is essentially a mathematical model which relates important social and economic variables. Mathematical relationships are employed to relate the intra and the interregional aspects of regional economies for the purpose of understanding better how the economy functions and for developing economic forecasts for the Boston Area.

In the following discussion the variables will be considered separately and then assembled into the comprehensive model that was actually used.

OPERATIONAL ELEMENTS

The operational elements of the model may be grouped conveniently for discussion into those which affect growth, due to changes internal to the region, and those which are external. The model itself does not provide for any but the most simple type of interrelation between variables. It does not make each variable dependent upon a number of other variables. These other, and sometimes very important relationships, between variables were considered apart from the operation of the model.

[illegible]

[illegible]

[illegible]

[illegible]

Intraregional Factors Affecting Growth

The mathematical model considers three variables as contributing to intraregional growth. They are: the population and the change in population, the labor force and the changes and internal shifts in the labor force, and the productivity and the change in the productivity of labor.

Population is the basic ingredient in the model. Labor force is determined through the use of rates of participation of the population in the labor force. Net production of a region is determined by multiplying labor force times net labor productivity.

Three rates of change are used to relate points in time. The first is the rate of change of population. The second is the rate of change of net worker productivity. And the third, is the rate of change in the participation of the population in the labor force. The model expresses intraregional growth of net production as the change in labor force and net worker productivity.

Population

Population is the basic ingredient in the model. It is basic because it is a significant determining factor, although there are others, in the size of the labor force. The rate of change in the population is a basic ingredient in the model not only because it affects the change in the labor force but it influences the rate of change in worker productivity.

The interrelation between population growth, and related labor

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

force growth, and the rate of change in net worker productivity may best be illustrated in terms of the concept of the production function which embodies the idea that many combinations of labor and capital may be used to achieve a specific volume of production. At any point in time, there is an optimum mix of the labor and capital used in production. This mix depends upon the price of labor and the price of capital. Thus, if there is a labor shortage or a slow growth in labor force, the price of labor will tend to be higher than if labor is in surplus or is expanding rapidly. When there is a relative labor shortage and the price of labor tends to be high, there will be a tendency on the part of the producers to substitute capital for labor, thereby attempting to increase labor productivity. Thus, slow growth in labor force might be associated with relatively high growth in worker productivity and, conversely, fast growth in labor force might be associated with slow growth in worker productivity.

Both may grow at once. E.g. automation + L.F. growth now = unemployment

Population growth at high rates might also indicate that an increasing share of total production would be used to sustain the consumption demands of the enlarging population. As a result, the residual capital available for increasing productivity would tend to be relatively small. Thus, population growth tends to be inversely related to the growth in net worker productivity.

- capital flow?

Any change in population may be explained in terms of the pattern of births, deaths, and migrations. By and large the pattern of births is related closely to economic conditions. In times of full employment and rapid income growth, the birth rates tend to be higher than in times of substantial unemployment and slow income growth. In short run economic analysis and forecasting, the pattern of births does not affect

directly the size of the labor force although it may affect the participation of secondary workers in the labor force. The pattern of births does not have a direct impact on the size of the labor force until the new babies are old enough to enter the labor force. Thus, in long run forecasts, specific consideration of the pattern of births might be justified as well as the consideration of the pattern of births as affected by economic conditions.

The patterns of deaths tend to exhibit some stability especially when viewed in terms of a population of a particular age and sex. However, the pattern of total deaths among a regional population would vary according to the age and race composition. While composition does not change drastically in the short run, a long run forecast might be justified in considering the impact of changes in composition on the pattern of deaths (and births, too), on the growth of total population and on the size of the labor force.

Migrations rather than natural increase affects the growth of population most. The pattern of interregional migrations is known to be related to economic opportunities; that is, migration occurs in the direction of greatest economic opportunities. The constant shifting of social and economic patterns tends to disrupt the equilibrium in their spatial arrangement. Migrations of people (and businesses too) occur in the process of bringing the spatial pattern back into equilibrium. ?, certainly not as it started.

The mathematical model used in this study, projects population in a gross fashion without considering specifically the patterns of births, deaths, and migrations, as they relate to economic opportunities and conditions. However, the model could be modified in subsequent

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

applications to do this, if even in a gross fashion by relating population growth to the potential for regional income growth.*

Labor Force

The rate at which the population of a region participates in the labor force is a function of the age and sex composition of the population as well as the economic opportunities of the region. The age and sex composition of the population influences the participation because it influences the number of persons of working age relative to the total population. A population with a high percentage of older persons or young children probably would have a low participation rate while a population with the bulk concentrated in the middle age group would have a higher rate of participation. While the model used here does not consider the impact of changes in composition on the participation rate, composition was considered in the use of the model in preparing the economic forecasts.

How?

The rate of participation of any population is limited by its composition but it is also affected by its rate of growth. When rates of increase are high because of high birth rates, the participation rate might be expected to decline somewhat because of the larger number of persons too young to enter the labor force. High rates of growth in population often are associated with low rates of participation.

redundant
3rd time

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*For a discussion of the use of income potential models for making population projections see: G.A.P. Carrothers, "Population Projections by Means of Income Potential Models", Papers and Proceedings of the Regional Science Association, v.4, Philadelphia, RSA, 1958.

The participation of the population in the labor force is affected also by income levels. Periods of prosperity have been associated with high rates of participation while periods of slow economic growth have been associated with low rates. It is hypothesized that as income opportunities increase, more persons are attracted into the labor force. This is particularly true for secondary workers and women. At the same time, one might expect that as income grows, increase in income would be taken as increased leisure, at least in part. This counterbalancing force tends to explain the long run historical decline in the work week. repetitive

In much the same way as data is converted into constant dollar, to account for changes in the value of the dollar, it is necessary to adjust labor force information for changes in the number of hours in the work week. An index denoting the relative change in the work week could be used to adjust the labor force data. In this study, however, this was not done. Rather, changes in work week were accounted for in the productivity of labor. This approach was used for the sake of convenience.

Net Worker Productivity

The basic definition of net worker productivity is the value of the total production minus the value of the assets consumed in the process of production divided by the average annual equivalent full time labor force, Gross worker productivity would be determined if the value of consumed assets were not deducted. Net worker productivity is the net amount of value generated by a worker working full time for one year after the value generated by land and capital are attributed to him.

of consumed assets are deducted.

Not correct, I think

Within productivity are considered a number of important factors which may vary from region to region. The composition of the industry of the region and the differential productivity generally associated with the specialization of the region, which tend to make total productivity vary among regions, are considered implicitly.

The characteristics of the labor force which may cause productivity differences among regions, such as overall difference in skills, education, age of labor force, organization of labor, etc. also are not considered specifically but are implicit in the derived productivity data.

Interregional Factors Affecting Growth

The model identifies three basic factors influencing regional growth which are considred in the evaluation of extraregional forces. 1) The first of these is the location of the region with relation to the other regions of the nation. The measure of the relative locational advantage of a region may be considered as the distance to other regions expressed in terms of the cost of overcoming this distance. This is assumed to measure the degree to which space impedes regional interaction. 2) The second factor is the purchasing power of the regions which may be expressed as the total personal income. In effect, this supplements the distance factor in that it considers the relative importance of the regions in terms of their demand for goods and services. The relationship established in the model may be described as an evaluation of the likelihood of reduced regional economic interaction as the

distance between regions increases and the likelihood of increased regional economic interaction as total personal income in the outlying regions increases.

How about persnl inc. w/in the region?

The final factor to be considered that influences regional interaction is the unique resources, composition, etc. of the region. Regional resource characteristics tend to alter the way in which space impedes interaction with other regions. The work of Ullman cited above illustrates clearly the differential affect that distance has on the economic interaction of the states studied and their hinterland. The California and Iowa comparison of the destinations of shipments of agricultural goods illustrates this well, ~~beautifully~~.

Locational Factors

The task of determining the locational position of the regions of the nation vis a vis each other, involves ~~the~~ measuring the economic distance between them. Distance per se, either air line, highway, or rail, are not representative of the economic friction of space. It is generally the case that the cost of shipping is not directly proportional to distance. Rather, the unit distance cost of shipping falls off as total distance increases.

The economic distance between regions may be considered as the cost of shipping a unit cargo via an appropriate mode of transportation. Such a definition of economic distance takes into account the distance factor as well as the related transportation rate. ~~As to~~ What is the appropriate mode depends upon the nature of the analysis and the substance of the activity sector under consideration. In some cases, railroad

transportation is appropriate. In other cases, trucking, airline, or communications are appropriate. Other problems arise even within a particular mode. Most obvious of these is the selection of the class of service. Thus, for example, the cost of shipping iron ore by rail would not be the same as the cost of shipping home appliances even when car-load lots are considered.

For this study, the cost of shipping a unit class 100 cargo by railroad between regions was used as the measure of economic distance. This measure was used because data for measures by other modes of transportation could not be obtained easily for the entire nation. From preliminary investigations, it appeared that the error incorporated in the study because of the across-the-board use of this measure would not be so great as to warrant being more refined.

esp. tertiary depends on other modes.

Another problem that emerges in determining the economic distance between regions, is the selection of the points between which the measurements are taken. This is particularly a problem when the region is large and has a number of significant urban areas within it. Measurements must be taken from some urban area because transportation charges are available on this basis only. For the purposes of this study, the measurements were taken from the urban center which was closest to the centroid of the population distribution of the region.

The cost of transporting a unit cargo between regions is used as the measure of the friction of space and as the measure of potential for the interaction between regions. The amount of regional income will affect interaction since as income increases in one region, the demand in that region for goods and services that are produced by another region is likely to increase.

Thus, the evaluation of the locational position of a region in an economic sense relative to potential markets for their production, may be viewed as two countervailing forces. On one hand, interaction tends to decrease as economic distance increases, while on the other, interaction tends to increase as income increases. Interaction is directly proportional to income and inversely proportional to economic distance.

what happened to UNIQUEness?

Resource Factors

As may be inferred from Ullman's work, income and distance are not the only factors which enter into an evaluation of economic interaction. The unique characteristics of the regions also must be considered in evaluating the relative amount of interaction. The social and economic organization of the region, the skills and abilities of the labor force, the fertility and characteristics of the land, the climate, the unique physical, mineral and institutional resources, the composition of the production of the region, all will influence, directly or indirectly, economic interaction with other regions quite apart from the economic distances between them.

A factor for each region reflecting the regional differences is incorporated in the model as delineated by Isard, to modify the measure of interaction reflected only by income and economic distance. The factor may be derived statistically for each region and projected for use in the preparation of forecasts.

It's a residual

Not used

How was uniqueness translated into a factor? And how can it change in the future?

THE COMPREHENSIVE MODEL

The basic model may be described as consisting of three parts. The first part, the dollar value of gross regional production, Gross Product, stands alone on one side of a mathematical equality and is generated by the sum of the other two parts. The two parts on the other side of the equal sign deal with the inter and the intra regional factors affecting gross production. The sum of the resultant intra and inter regional effects equal the total or gross production.

GP Intra =
L x P

The intraregional portion of the equation is basically the labor force times the net productivity of labor. This product equals the net production of the region. This portion of the model contains all of the elements required to make forecasts of net production from any base year where the population, net worker productivity, and the participation rate is known. Three rates of change are employed to make the forecast, they are: the rate of change in population, the rate of change in worker productivity, and the rate of change in the participation of the population in the labor force. The operation of the model is as follows. Population in the base year times the rate of change equals the population at some future date. Participation rate in the base year times the rate of change equals the participation at some subsequent date. The forecasted population times the future participation rate equals the future labor force. The productivity in the base year times the rate of change equals the productivity at the later date which when multiplied by the future labor force yields the forecast of net production. To this must be added the extra production of the region

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[illegible]

[illegible]

stimulated by the economic and social pattern in the other regions.

In a given spatial arrangement of regions, the effect on a particular region of the changes in social and economic patterns in other regions is related directly to change in whose? their income dampened by their distance away, and the changes in the resource characteristics of the region in question which enable it to compete in these distant markets. How do you get at this? A single number is generated from the distance, income and resource factors which represent the rate of change in the extra production from the base year to some future date. The extra production, at some future date is expressed in the model as a rate of change times the extra production in the base year.

These are the basic relationships considered in the model. The model may be used for analyses and forecasts for the total economy and for subdivisions of the total economy.

The Sectoral-Total Relationship

Quite apart from the relationships incorporated in the mathematical model, there are governing conditions which influence its use. These conditions deal with the summation of information used in the model and the information generated by the model for the economic activity sectors and the regions of the nation.

Horizontal Relationship

Economic analyses and forcasts are made of the total production for the nation and each region. Analyses and forecasts are made also

of the Primary, Secondary, and Tertiary Industry of each region and of the nation. The first governing condition is that the sum of the forecasts for the three activity sectors must equal the forecast of the total for any particular geographical area, whether it is a region or the entire nation.

There are four items forecasted in the model that must meet this condition. They are labor force, net production, extra production, and gross production.

Don't understand,

Vertical Relationship

Inasmuch as economic analyses and forecasts are prepared for regions as well as the entire nation, the second condition to be met is that the sum of the regional forecasts for any activity or the total must equal the forecasts of the corresponding grouping for the nation; that is, the sum of parts must equal the whole. Five items forecasted in the model must meet this condition. They are Population, Labor Force, Net Production, Extra Production, and Gross Production.

Regional National Relationship

The national forecasts for the total economy and each of three activity sectors may be regarded as the basic framework within which the regional forecasts are made. The forecast of the total economy of each region acts as a framework within which the activity sectors in that region are made. Thus, each forecast for the nation and the nine regions must be in balance, that is, they must be interrelated so that the rates of change produce inputs and outputs which meet these governing conditions.

Output

The features of the method of preparing regional forecasts of output, Gross Product, has a distinct advantage over other methods. The local forecasts are based upon national forecasts of GNP. Because of the large size and heterogenity of the base, national forecasts of Gross Product tend to be more reliable than forecasts for smaller subdivisions of the nation and much more reliable than forecasts for a single city. Thus, by using national forecasts of GNP as a basic framework for local and regional forecasts, rather than mere extrapolation of local trends in production, the often arbitrary means of preparing local forecasts is replaced by a more responsible technique which, hopefully, will yeild more reliable information.

The forecasts of local output are based also on regional growth differentials via the feature of the method which relates regional economies in space. unclear?

Input

In terms of the summation of all of the items that go into the generation of net production, there is the operational problem of choosing rates for making the forecasts such that the summation conditions are met. The rates involved, of course, are the rate of change in population and productivity and the rate of change in the way the population participates in the labor force.

The process of achieving a balance in the input and output may be conceived as a circular one. The circular process involves the making of successive adjustments based upon past performances and future potential, both in terms of the output information and the rates used to

generate the output. Through a series of adjustments, the amount of mathematical error is successively reduced.

Region to Region Relationship

One final matter remains to be explained fully about the comprehensive model before discussing how the economic measurements implied in the model were made. This matter relates to the operation of the income potential portion of the model that generates the extra production based upon extraregional growth in demand, which, when added to net production equals Gross Production.

In the context of regional analysis a web of interdependencies between regions is recognized. No region is entirely self sufficient; each region depends upon other regions for some of the goods and services it requires and produces for the requirements of other regions. Thus, changes in economic factors in the regions of the nation affect the Boston region.

The basic premise of the methodology is that the affect on Boston of variations of economic factors in other regions is a function of the magnitude of the variation in income and the economic distance to the other regions of the nation. The potential for local economic interaction with other regions at any point in time is a number which is determined by summing the income of each region divided by the economic distance between it and the Boston area. The rate of change of this numerical index of the potential for interaction between any two years is considered as the rate of growth of the extra production in the Boston area.

MEASURING ECONOMIC GEOGRAPHY FACTORS

Remaining to be treated are the techniques of measuring economic factors and their use in the model of the national economy. Among these are the basic concept of measuring production and income and the measuring stick employed as well as the techniques for evaluating change. Following a discussion of these factors is a section dealing with the use of the model in making analyses and forecasts and the development of the inputs from an operational viewpoint.

The Basic Concept

The basic concept for measuring the economy stems from the definition of such ideas as the Gross National Product and the National Income. These definitions for measuring the economy were developed during the 1930's for the purpose of determining the status of the economy as a basis for making policies and determining how effective past policies have been in coping with the economic crisis of that era.

Paul Samuelson* gives an excellent description of the concept of National Product and the related concept of Gross National Product. National Product is defined as the money value of the annual flow of goods and services. Figure (XIII) defines National Product by illustrating the two methods that may be employed to measure it.

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*P. Samuelson, Economics, An Introductory Analysis, Fourth Edition, New York, McGraw Hill, 1958, Ch. 10.

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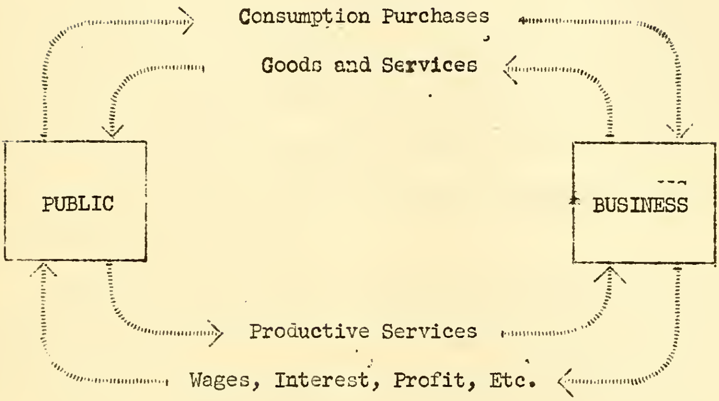
[illegible]

Figure XIII

NET PRODUCT IS MEASURED AS A FLOW OF OUTPUT OR AS EQUAL FLOW OF COSTS.*



The first method is illustrated by the upper loop. This method measures the dollar value of the flow of goods and services (apples, oranges, haircuts, etc.) from the producer to the consumer in terms of their value as reflected in prices paid by the consumer. Using this method, National Product is the sum of the annual flow of: the number of oranges times the price of an orange, the number of haircuts times the price of a haircut, etc.

The second method of measuring National Product is illustrated by the flow through the lower loop. This method measures the dollar value of production services in the form of labor, capital, etc. as

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*Ibid., p. 182.

reflected in the prices paid for these services, i.e., wages, salaries, interest, rents, profit, etc. By definition, the National Product computed by each method are equal.

In this illustration, it is assumed that everything that is produced is consumed, that everything earned is spent. In reality, however, this is never achieved exactly since some income earned during the year is not spent but rather saved for future expenditures and some goods purchased are not consumed entirely during the year. At times, some income not earned during the year is spent and some goods not purchased during the year are consumed.

This difference between consumption and income is defined as the net capital formation or net investment and includes the stock of buildings, equipment, goods produced but not sold (inventories) etc.

When capital consumption is exactly equal to the production of capital goods during the course of a year, then there is no change in the capital stock. However, if capital consumption exceeds the production of capital goods, then the stock of capital goods at the end of the year will be lower than at the beginning by an amount equal to the excess. Similarly, if production of capital goods exceeds consumption then the stock will be higher at the end of the year.

By definition, Net National Product is the total value of goods and services produced minus the capital goods consumed in their production, i.e., minus the depreciation of capital goods. Gross National Product, however, is defined merely as the total value of goods and services produced without deducting the value of the capital goods consumed in production.

In this study, Gross National Product is the concept used for measuring the overall performance of the economy. National Income data, assembled by the U.S. Department of Commerce, was used as Net Product data because it was readily available even though its-definition is different. The difference is that National Income is less than National Product by an amount about equal to Indirect Business Taxes.

Measuring the Pattern

The traditional yardstick for measuring the economic patterns has been the dollar. The dollar is the unit of measurement employed in the concepts of Gross National Product and National Income.

The use of the dollar for this purpose has been satisfactory for indicating the position of the economy as of a particular point in time. However, a significant problem arises in its use when a comparison is made between different points in time. The problem results from the change in the value of the dollar over the period. The use of the current dollar yardstick is in effect the use of an elastic or rubber measuring rod.

The traditional technique for preparing a non-elastic yardstick is to use constant dollars rather than current dollars; that is, to use dollars that represent the same level of purchasing power at each point in time rather than dollars representing different levels of purchasing power. The conversion of current dollars to constant dollars is achieved through the use of indicies prepared by the Bureau of Labor Statistics, U.S. Department of Labor. The Bureau of Labor Statistics assembles

indicies of the price changes of a number of commodities. The exact index employed depends upon how the converted information is to be used.

The consumer price index was used for converting data to constant dollars.* As a weighted composit of the price index of several commodities it is suitable because the object of the study is the economy in general rather than any specific detailed component.

Table V

FACTORS FOR CONVERTING CURRENT DOLLARS INTO 1959 CONSTANT DOLLARS*

what about the future? 1959 $?

Year	Factor	Year	Factor
1959	100.0	1943	168.1
1958	100.9	1942	178.1
1957	103.4	1941	198.0
1956	107.1	1940	208.0
1955	108.3	1939	209.2
1954	108.3	1938	206.7
1953	108.3	1937	203.0
1952	109.6	1936	210.5
1951	112.1	1935	211.7
1950	120.8	1934	217.9
1949	122.0	1933	225.4
1948	120.8	1932	213.0
1947	130.8	1931	191.8
1946	149.4	1930	174.3
1945	161.9	1929	169.4
1944	165.6		

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*Adapted from the Consumer Price Index, U.S. Department of Labor, wherein the purchasing power of the dollar was expressed with the period 1947-49 as the base. The 1959 dollar equals .803 of the 1947-49 dollar.

Absolute and Relative Change

The comparison of economic patterns over time in making economic analyses of historical patterns and the projection of future patterns involves deriving and reviewing rates of change. Arithmetic rates of change may be used for projection of the absolute change regardless of the size of the base. For example, if an economy of 100 changed five units each year, the projection using arithmetic rates would add five units for each year. The economy would reach 200 at the end of twenty years. However, the percentage increase in the first year would be five percent and would decrease to two and one-half percent in the twentieth year.

The use of arithmetic rates in this manner cannot often be justified because it ignores the influence of the capacity of the economy to generate growth; it ignors the magnitude of the base. The use of geometric rates of change does overcome this difficulty. By using geometric rates, the rate is held constant for all years and the absolute value of the increment varies from year to year. Geometric rates can best be described in their use in banking, i.e., compound interest, where the amount of the annual interest is dependent upon the size of the balance in the account. In this study, geometric rates of change have been used throughout.

Synthesis

In the process of making historical economic analyses, the rates of change between two specific years may be computed by standard methods

when the quantities are given for those years. Basically, the computation of the rate of change is that subtracting the number one from the "t"th root of the quotion of the quantity in the second year divided by the quantity in the first year where "t" is the number of years in the interval. unclear This procedure was employed in analyzing the change in population, labor force, worker productivity, and relative income potential. The determination of the resource factor which influences the distance variables is achieved as a residual, once the rates of change and the change in income potential, considering only incomes and distances, are known. How?

Through historical analyses, a better understanding of the evolution of regional economic patterns and the relationships between them may be obtained. This background knowledge is generally useful in the development of the material for making the economic projections. The process of developing the rates of change for making the projections for use in the economic model is not that of extrapolating historical trends, although past performance is considered. The process is that of balancing the model through a series of adjustments such that the regional forecasts of population, labor force, productivity, and gross product, ~~sum~~ add up to the forecasts for the entire nation; that is, the sum of the parts equal the whole.

Section C: LIMITATIONS OF THE METHOD

While the methodology employed in this study represents an advancement in the development and use of improved economic analysis techniques, the economic model cannot be viewed as the ultimate method. There are limitations in the model, both conceptual and in application, which relegate it to being a modest advancement in economic analysis.

CONCEPTUAL LIMITATIONS

The intelligent use of the economic model and the proper interpretation of the results of its use requires an understanding of the conceptual deficiencies implicit in the model and the assumptions which must be made to handle these deficiencies.

Problems Implicit in the Model

There are a number of factors which the economic model, as used here, does not cope with directly. Many of the more sophisticated economic models do not handle these factors either. In the use of the model these factors must be dealt with outside of the operation of the model, that is, in the derivation of values used in the preparation of forecasts.

The first of the factors not handled directly in the operation of

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[illegible]

But does it demand get handled in the GNP

the ~~economic~~ model) is the consumption or the demand side of the economy. The model used here, as well as most other economic models, are concerned essentially, with the production or the supply side of the economy. They do not consider explicitly, the demand for goods and services. No provision is made in the model to evaluate market demands explicitly, in the process of making historical analyses. In the process of forecasting economic activity, expected and forecasted shifts in consumer demands must be determined outside of the model and the effects of these shifts on output must be injected into the model in the selection and adjustment of input values used in making the forecasts.

The second consideration not handled directly by the model is the subject of production factors. Technological advances in production processes, the substitution of new goods and services, and the substitution of production inputs are among the most important omissions. Some attempt is made to bridge this gap through the determination of rate of change in worker productivity as related to the rate of change in labor force and population. In adjusting worker productivity, technological and social factors which affect production may be injected in a general way only, into the model. The development of rates of change in worker productivity in connection with labor force and population growth does permit the consideration of the substitution of production factors in a generalized fashion. However, the explicit treatment of possible substitutions between all goods and services as affected by prices and other factors (~~in the use of the~~ model for forecasting) is not achieved easily.

Basic to the handling of the above factors is the consideration

of prices and the shifts in prices of goods and services, the third factor not considered specifically in the model. It is generally understood that the movement of prices as well as the concomitant movement in incomes affects not only the demand for goods and services by individual and enterprenuerial consumers but also affects the emergence of new products and services. Together, these could greatly affect the economy and account for the inaccuracies of the forecasts. How ?

The fourth deficiency in the model, is the nonrecognition of the variations in wealth and income as related to the population and the variations in the living requirements, consumption, etc., in the different regions. While the model does consider generally, the affects of gross regional income variations, this refinement would clear the way for coping with some of the above deficiencies.

The fifth omission from the operation of the model is the inability to consider even generally, the shifts in the resource and trade patterns among the regions. The development of the model recognized in a most general and aggretive way, the historical trade pattern and essentially holds them constant in subsequent use of the model.

The sixth and last deficiency, is that the model does not establish the interrelation between sectors of the economy. It does not consider the multiplier effect of shocks in one sector on the others. Obviously, the economy is a unit and when subdivided into sectors for the purpose of convenience, the relationships between sectors must be considered.

But I thought it did through the potential-grants?

Methodologies suitable for use in connection with the model used here to overcome these difficulties are being formulated by theoreticians and scholars and are published particularly by the Regional

Science Association. However, while the methods are developed, much of the basic information required for their use is either lacking or difficult to assemble.

Assumptions Implicit in the Model

Recognizing these conceptual problems, it was necessary to make assumptions about them which properly should accompany the published economic analyses and forecasts. Inasmuch as the demand side of the market is not thoroughly considered, the first and broadest assumption implicit in the model is that the goods and services produced can and will be consumed and, except for cyclical variations, supply and demand will be in balance, in the long run. In support of this assumption, it may be argued that generally changes in purchasing power accompany changes similar in direction in production. It may be argued that only a sharp disturbance, unforseen at this time, would alter this balance over long periods.

The second major assumption deals with the impact of technological progress and the substitution of production factors and goods and services. While it is recognized that technological progress will occur, it is assumed that the occurrence will not be so abrupt ~~such~~ as to disturb the economy greatly or so greatly favor one or a few regions at the expense of the others, that the differentials in growth forecasted will be upset. It is assumed that these shifts will occur gradually, that their impact will become evident over a period of time, and that counter balancing shifts dampening the impact on the economy will occur as a result of local efforts and governmental activities.

With regard to price movements, it is assumed that the relative prices of goods and services will not vary greatly from the present relationship and that the overall price movements relative to incomes will be such as to stimulate the demands for additional goods and services and thus stimulate economic growth. Essentially, it is assumed that there will be no critical shortages.

With regard to regional variations in the pattern of wealth and consumption, it is assumed that they will remain relatively the same. It is assumed that shifts in these patterns will be gradual and that other forces will operate to set off counterbalancing shifts.

LIMITATION OF APPLICATION

A number of difficulties arose in the use of the methodology for making economic analyses and forecasts. On one hand, the difficulties emanated from the lack of required information and the necessity to make estimates of the information for the purpose of carrying out the study. On the other hand, the difficulties resulted from the nature of models, i.e., the need to assemble vast amounts of information for the study and to review the vast amount of information that was generated in the process of making the economic analyses.

Lack of Required Information

The most important lack of information was for the City of Boston

and the Boston Metropolitan Area. Average annual equivalent full time
1
labor force information, worker productivity data, personal income statistics, and the value of gross production were virtually unavailable for these areas. The only information that could be obtained were population statistics. Much of the information that was needed was compiled only for states but not for smaller subdivisions of states: metropolitan areas and central cities. The second most serious lack of information was the unavailability of net and gross production and net labor productivity data by states or regions.

The value of gross productions by regions, which, when summarized, equals the GNP, was estimated from personal income statistics published by the U.S. Department of Commerce.[*] The estimates of total Gross Regional Product were prepared by increasing the total of regional Personal Income by the ratio of the national Personal Income to GNP. Variations on this procedure using different factors for blowing up Personal Income data were used to determine regional product for Primary, Secondary, and Tertiary industries. This was done by allocating shares of the items that make up the difference between Personal Income and GNP to these three industry categories. Then GNP Personal Income ratios were developed for each industry category for the nation to be used in blowing up regional Personal Income by industry to gross product.

The estimates of net worker productivity were prepared by dividing the estimated value of the net production for the region by the average annual equivalent full time labor force. Net Product by region was estimated in a manner similar to the procedure for estimating Gross Product. Average annual equivalent full time labor force data for Primary Industry

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[*] U.S. Department of Commerce, Personal Income by States since 1929, Washington, GPO, 1956, and subsequent Survey of Current Business.

was difficult to assemble primarily because of the unavailability of comparable data for Forestry and Fisheries (See Appendix A.).

There is an overall data problem with regard to self employed workers and property income. While BLS publications maintain that all workers are included in their statistics, it is not specifically stated nor does the estimating technique specifically endeavor to include self employed workers. Hence, it is quite possible that these members of the labor force are not included in the statistics and that our data is on the low side.

With regard to Property Income, the data problem arises in the determining of the source of the income as related to the three sector breakdown of the total economy. Property Income is listed by state but it is not broken down by source. It is, however, broken down for the nation by pecuniary income from interest, rents, and dividends from public and private sources and by imputed interest and imputed rents from owner occupied dwellings. The imputed income could be assigned to Tertiary Industry, however, assumptions about the distribution of property income from rents, dividends and interest had to be made as a first step in allocating this income to the three sectors of the national economy. The same proportionate national distribution of property income among the sectors was used to determine the allocations for the regions.

Accuracy of the Estimates

The accuracy of the estimated information is difficult to determine unless subsequently, the correct information is found. This

information is virtually unavailable, however. In the opinion of the study staff, the estimates per se, appear to be within an acceptable range of accuracy in terms of their own order of magnitude and in terms of the accuracy required for the analysis.

Development of Input Values

The development of input values for the purpose of making economic forecasts as well as the reviewing of the information obtained in the historical analysis is a difficult and trying process. Inasmuch as automatic data processing techniques were used for making all of the mathematical calculations, virtually all of the computations which seemed necessary in the analysis were made and the results were printed. The print-offs consisted of hundreds of pages of figures which it was the task of the study personnel to review and interpret. The task of making sense of all of these figures is indeed a difficult one.

The development of the rates of change for each of the variables for each of the four sectors of nine regional economies such that the summation conditions are met, involves the determination of 144 rates of change and their subsequent adjustment. Not only is it necessary to determine these rates such that the summation conditions are met but these rates must make sense in terms of one another within a particular region and between regions. In this study, the determination of rates was entirely a manual task quite demanding of time and talent. Economic concepts were employed along with forecasts of growth trends made by governmental and private research organizations to make the determination of growth rates.

Section D: FUTURE USE OF THE MODEL

In this first complete application of the newly devised mathematical model some of the problems and potentials of the model have been identified. During the present application the theoretical first statement of the model has been adapted to operational use by research and planning agencies. Some of the problems associated with the operational use of the model have been solved in the present application and recommendations related to the unsolved problems and the more effective use of the model can be made. Through this application the potential of the model in assisting in planning and decision-making is more clearly understood. The following discussion is presented for the benefit of those who engage in economic research and of those who may utilize the present work as a base for subsequent use of the model.

FUTURE APPLICATIONS

It is heartily recommended that the information and methodological resources assembled and generated in the course of carrying out this study be capitalized on and developed further rather than filed away never to be used again while other groups are duplicating this effort. The basic historical data required for economic analyses has been assembled in orderly form and is available both for visual review as well as for immediate use with automatic data processing equipment. Print-offs of population, labor force, worker productivity, and

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gross regional products along with all of the rates of change have been made. These data are available also on punched cards which may be used as is in performing subsequent analyses on punched card computers. Thus, this information may be used easily, requiring only that it be brought up to date for future use.

Available also are the operational systems for carrying out the process of preparing economic analyses and forecasts. The work program, personnel requirements and the data processing procedures and program as developed for this study would be made available to those who take over the program.

Continuing Research Function

A number of groups throughout the Boston Metropolitan area prepare, from time to time, economic analyses and forecasts for publication. In some cases, as in this one, these studies are undertaken for some specific purpose. Only a few agencies perform economic analyses and prepare economic forecasts on a continuing basis, such ? that the community is aware of recent changes in the economic pattern and what is the probable economic outlook in the long and short run.

The economic model used in this study lends itself readily to making inexpensive and rapid analyses of new information as it becomes available and the revision and updating of economic forecasts because the methodology and all of the computer programs have been worked out and are ready to be used. Desirably an organization that is continually engaged in economic research and has a medium such as a newsletter to diseminate its findings should take up the

parallel

work completed here and use it as a base for performing continuous economic research along these lines in conjunction with its other work. If this is done, the efforts of this study in collecting, analyzing and organizing basic economic information and in the development of better analysis and forecasting tools will not be wasted.

Other Uses for the Model

In the future the model may be used as it was used in this study, but desirably the model should be developed further to realize its full potential. In this study the model was not used to evaluate the impact on Boston and its Metropolitan area of alternative shifts in economic patterns in other regions of the nation. This use of the model for determining the local consequences of alternative and/or hypothetical extra regional situations, essentially on a continuing basis, would establish the technique as a working tool for planners and decision-makers throughout the entire area.

There are a number of other possible applications of the model which have not been made in this study. The basic formulation of the model may be utilized by research organizations in other cities by subdividing the nation into slightly different regions or by subdividing the total economy in a different way, depending upon the purpose of the analysis and forecast. Only a minimum amount of work would be necessary for these agencies to get going on their own economic base studies.

Perhaps the most important general use of the model is in connection with other studies, which are concerned with parts of

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the whole or parts of the parts of the economy. The use of the model in connection with other social and economic studies would provide a means of relating the parts to the whole both economically and spatially.

RECOMMENDED DEVELOPMENT OF THE TECHNIQUE

Some general recommendations can be made regarding the development of the methodology employed in this study as it may be related to other work. Specific recommendations related to the improvement of the use of the model in making historical analyses, especially in the evaluation of resource factors, and in making economic projections will not be made here. Rather, only the general lines along which the application and development of the technique may proceed are noted.

A Base for Other Methodology

It is possible to incorporate the work performed here with other methodologies for the purpose of improving the quality of economic analysis and forecasting and to bridge some of the conceptual gaps. One obvious possibility is a wedding between the income potential feature of the present model and the more elaborate econometric techniques such as the input-output methodology. This would add to the input-output technique, which is essentially non-spatial, the ability to consider the impact of space on economic activity and growth.

The wedding between these two techniques would enable the broad aggregates of the economy treated in the present study to be detailed

further and the industrial interrelations lying behind regional change to be traced out.

Policy Evaluation

It is recommended that the future development of the model be oriented towards being a tool for the evaluation of the consequences of policy alternatives open to public and private enterprise. For government it would be a beneficial new tool for evaluation public policies before they are implemented to determine the extent to which they may be expected to achieve the desired ends and to determine what are the possible side consequences that may occur as a result of their implementation. By testing policies before implementation, the most effective policy may be chosen. Subsequently, government can evaluate what has happened to determine in actuality how effective the policy was. Such a tool would be useful for government at the Federal, State, and Local levels. Private enterprise also would also find the model useful for evaluating their policies.

Examples

Because of the wide range of interests of government, it would be desirable to develop the model further such that so? the relations between the economy and social and physical factors are included in the model. By this means, the model will be more useful to policy makers and decision makers.

A Comprehensive Tool

A comprehensive model of this type would be a mathematical analogy of the real world which would consider all of the important

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social, economic and physical factors and the interrelations between them. The model may be viewed as a tool for the use of planners and decision makers and would be used to give some indication of "what would happen if . . ." It would be set up to determine the probable social and economic consequences of alternative courses of action by government and private enterprise.

In putting a question to the model, the answer would be given in terms of the changes in the composition and characteristics of the population, the patterns of inter and intrametropolitan migrations, shifts in employment patterns, changes in output and income, changes in the pattern of consumption and investment, changes in the inter and intrametropolitan flows of goods and the consequent impact on the balance of payments, the impact of the shifts on land use and the tax base as well as the transportation system. The comprehensive model would permit the evaluation of alternative courses of action in a comprehensive fashion in terms of the main objectives as well as the many related side issues. The following chart outlines in a most simple way the organization of such a model.

APPENDIX

Appendix A: DATA AND DATA SOURCES

There are only a few basic data that must be assembled for a regional and national economic analysis by the methodology used in this study. The bulk of the other data used in the study is derived from this information. The basic data required for the nation and the regions are Population, average annual equivalent full time labor force, Income and Output, and the economic distances between regions.

Population data for the study was obtained from the publications of the Bureau of the Census, U.S. Department of Commerce.* These data are available by states, the Boston Metropolitan Area and the City for 1930, 1940, 1950 and 1960. The Population for the intervening years is estimated from these benchmarks.

The bulk of the labor force data required may be obtained from the publications of the Bureau of Labor Statistics, U. S. Department of Labor.+

The publications list for the nation and for each state the average annual labor force. These data may be conveniently summarized to derive labor force information for the regions of the nation by the Secondary and Tertiary Industry categories used in this study.

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* Bureau of the Census, U.S. Department of Commerce, United States Census of Population, the 15, 16, 17, 18th Decennial Censuses, Washington, GPO.

+ Bureau of Labor Statistics, U.S. Department of Labor, Employment and Payrolls, Washington, U.S. Dept. of Labor, 1953 and subsequent editions. Equivalent fulltime average annual labor force data is available for all states for each year since 1939 to the present and for all industries in the categories of Secondary and Tertiary Industry used in this study.

Appendix A: DATA AND DATA SOURCES

There are only a few basic data that must be assembled for a regional and national economic analysis by the methodology used in this study. The bulk of the other data used in the study is derived from this information. The basic data required for the nation and the regions are Population, average annual equivalent full time labor force, Income and Output, and the economic distances between regions.

Population data for the study was obtained from the publications of the Bureau of the Census, U.S. Department of Commerce.* These data are available by states, the Boston Metropolitan Area and the City for 1930, 1940, 1950 and 1960. The Population for the intervening years is estimated from these benchmarks.

The bulk of the labor force data required may be obtained from the publications of the Bureau of Labor Statistics, U. S. Department of Labor.+

The publications list for the nation and for each state the average annual labor force. These data may be conveniently summarized to derive labor force information for the regions of the nation by the Secondary and Tertiary Industry categories used in this study.

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* Bureau of the Census, U.S. Department of Commerce, United States Census of Population, the 15, 16, 17, 18th Decennial Censuses, Washington, GPO.

+ Bureau of Labor Statistics, U.S. Department of Labor, Employment and Payrolls, Washington, U.S. Dept. of Labor, 1953 and subsequent editions. Equivalent fulltime average annual labor force data is available for all states for each year since 1939 to the present and for all industries in the categories of Secondary and Tertiary Industry used in this study.

Labor force information for the Primary Industry category, however, was not so easily assembled. The U.S. Department of Agriculture does publish similar data for farm employment.[*] Comparable figures for the industry categories of Forestry and Fisheries were not available. Only employment figures as of a particular day or month by states were available by special request from the Department of the Interior. At best they were useful for making estimates of equivalent full time average annual labor force. Fortunately, the labor force in these industries is but a small percentage of the total employment in Primary Industries, in most regions.

Comparable labor force information for Boston and the Boston Metropolitan area were unavailable except for some years from the BLS publications. The required information for other years has to be estimated from the Massachusetts Division of Employment Security statistics on covered Employment.

Income and output data was difficult to obtain for the city of Boston and the Boston Metropolitan Area. For these areas, the data had to be estimated from state data based upon Massachusetts DES information. Personal income data for the nation and all of the states by source of income was available from U. S. Department of Commerce Publications.[+]

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[*] U. S. Department of Agriculture, Farm Employment, Statistical Bulletin No. 236, Washington, USDA, Sept. 1958. Agricultural labor force information is available for the nation and by states although only from 1950 to the present.

[+] U. S. Department of Commerce, Office of Business Economics, Personal Income by States since 1929. Washington, GPO, 1956; and Survey of Current Business, published monthly.

These data also can be summarized easily by regions.

Regional National Income and Gross Product data by states and by regions is not available although required for the study. As noted above, these data were estimated using Personal Income statistics as a base.

The remainder of the data used in carrying out the historical analysis was generated in the course of performing this work. All of the rates of change were determined by evaluating the basic data between two points in time. In the following tables are listed the economic forecasts for the City of Boston, the Boston Metropolitan Area and the United States. The basic information collected for the study program is not presented here but may be obtained from the Planning Department of the Boston Redevelopment Authority.

Table VI

GROSS PRODUCT FORECASTS
FOR
The United States
The Boston Metropolitan Area
The City of Boston

Billions of $

	HIGH			LOW		
	Boston	BSMA	Nation	Boston	BSMA	Nation
YEAR	TOTAL GROSS PRODUCT					
1960	4.07	8.12	505.	4.01	8.04	500.
1962	4.34	8.75	545.	4.17	8.15	529.
1965	4.77	9.8	614.	4.42	9.30	569.
1970	5.58	11.9	747.	4.90	10.5	674.
1975	6.55	14.	910.	5.40	12.0	777.
1980	7.66	17.	1115.	5.97	13.00	906.
1990	10.44	25.2	1619.	7.26	17.8	1213.
2000	14.42	34.39	2424.52	8.85	23.24	1631.02
YEAR	GROSS PRODUCT OF SECONDARY INDUSTRY					
1960	.82	2.77	198.71	.81	2.74	196.80
1962	.87	3.	215.	.84	2.9	204.
1965	.96	3.3	242.	.89	3.14	213.5
1970	1.12	4.	294.	.98	3.6	260.
1975	1.31	4.6	359.	1.08	4.1	300.
1980	1.53	5.6	438.	1.18	4.7	345.
1990	2.04	8.2	620.	1.42	6.1	457.
2000	2.84	11.75	947.95	1.71	7.96	607.02
YEAR	GROSS PRODUCT OF TERTIARY INDUSTRY					
1960	3.25	5.35	283.14	3.20	5.30	280.27
1962	3.47	5.75	307.	3.33	5.6	301.
1965	3.81	6.5	348.	3.53	6.16	330.
1970	4.46	7.9	425.	3.92	6.9	385.
1975	5.24	9.4	519.	4.32	7.9	445.
1980	6.13	11.4	640.	4.79	8.3	525.
1990	8.4	17.	950.	5.84	11.7	710.
2000	11.58	22.64	1411.68	7.14	15.28	965.71

Table VII

POPULATION FORECASTS
FOR
The United States
The Boston Metropolitan Area
The City of Boston
(Millions)

YEAR	HIGH			MEDIUM			LOW		
	Boston	BSMA	Nation	Boston	BSMA	Nation	Boston	BSMA	Nation
1960	.72	2.5	179.	.72	2.5	179.	.72	2.5	179.
1962	.72	2.57	185.5	.72	2.56	184.5	.71	2.54	183.5
1965	.73	2.69	195.5	.71	2.65	192.7	.69	2.61	190.4
1970	.73	2.90	213.3	.70	2.81	207.2	.67	2.74	202.4
1975	.73	3.12	232.7	.69	2.98	222.7	.65	2.88	215.1
1980	.73	3.35	253.9	.68	3.16	239.5	.63	3.02	228.7
1990	.74	3.88	302.3	.66	3.55	276.8	.59	3.33	258.4
2000	.75	4.5	360.	.65	4.00	320.	.55	3.65	292.

Table VIII

PERSONAL INCOME FORECASTS
FOR
The United States
The Boston Metropolitan Area
(Billions, 1959 Dollars)

YEAR	HIGH		LOW	
	BSMA	Nation	BCMA	Nation
1960	6.20	385.5	6.14	381.7
1962	6.68	416.	6.49	403.8
1965	7.48	468.7	7.10	434.4
1970	9.08	570.	8.02	514.5
1975	10.69	694.7	9.16	593.1
1980	12.98	851.1	10.00	691.6
1990	19.24	1235.9	13.59	926.
2000	26.25	1850.8	17.74	1245.1

3 pop national forecas
2 GNP = 6

Table IX.

FORECASTS OF PER CAPITA PERSONAL INCOME

BY GROWTH ASSUMPTIONS

GNP	High	High	High	Low	Low	Low
POPULATION	Low	Medium	High	Low	Medium	High
PARTICIPATION	High	Medium	Low	High	Medium	Low
PRODUCTIVITY	High	Medium	Low	High	Medium	Low
YEAR			BOSTON METROPOLITAN AREA			
1960	2480	2480	2480	2456	2456	2456
1962	2630	2609	2599	2555	2535	2525
1965	2866	2823	2781	2720	2679	2639
1970	3131	3231	3131	2927	2854	2766
1975	3712	3587	3426	3181	3074	2936
1980	4298	4108	3875	3311	3165	2985
1990	5778	5421	4959	4081	3828	3503
2000	7192	6563	5833	4860	4435	3942
YEAR			UNITED STATES			
1960	2154	2154	2154	2132	2132	2132
1962	2267	2255	2242	2201	2189	2177
1965	2462	2432	2397	2282	2254	2222
1970	2816	2751	2672	2542	2483	2412
1975	3230	3119	2985	2757	2663	2549
1980	3721	3554	3352	3024	2888	2724
1990	4783	4465	4088	3584	3345	3063
2000	6338	5784	5141	4264	3891	3459

Table X

FORECASTS OF LABOR FORCE FOR THE CITY OF BOSTON BY GROWTH ASSUMPTIONS

(Millions of Equivalent Full-Time Workers)

GNP	High	High	High	Low	Low	Low
POPULATION	Low	Medium	High	Low	Medium	High
PARTICIPATION	High	Medium	Low	High	Medium	Low
PRODUCTIVITY	High	Medium	Low	High	Medium	Low
YEAR	TOTAL EMPLOYMENT					
1960	.49	.492	.494	.488	.49	.492
1962	.49	.495	.496	.487	.491	.495
1965	.49	.500	.503	.487	.493	.500
1970	.492	.507	.515	.486	.496	.511
1975	.492	.514	.527	.486	.499	.522
1980	.494	.520	.540	.486	.504	.535
1990	.496	.436	.565	.483	.511	.557
2000	.50	.54	.59	.48	.52	.57
YEAR	EMPLOYMENT IN SECONDARY INDUSTRY					
1960	.105	.105	.106	.104	.104	.105
1962	.104	.105	.106	.103	.103	.105
1965	.103	.106	.106	.101	.102	.105
1970	.102	.107	.107	.098	.100	.106
1975	.099	.107	.107	.095	.098	.106
1980	.097	.108	.108	.092	.097	.107
1990	.093	.109	.109	.086	.093	.108
2000	.09	.10	.11	.08	.09	.10
YEAR	EMPLOYMENT IN TERTIARY INDUSTRY					
1960	.385	.387	.388	.384	.386	.387
1962	.386	.390	.390	.384	.388	.390
1965	.387	.394	.397	.386	.391	.395
1970	.390	.400	.408	.388	.396	.405
1975	.393	.407	.420	.391	.401	.416
1980	.397	.412	.432	.394	.407	.428
1990	.403	.427	.456	.397	.418	.449
2000	.41	.44	.48	.40	.43	.47

Table XI

FORECASTS OF LABOR FORCE
THE BOSTON METROPOLITAN AREA
BY GROWTH ASSUMPTIONS
(Millions of Equivalent Full-Time Workers)

GNP POPULATION PARTICIPATION PRODUCTIVITY	High Low High High	High Medium Medium Medium	High High Low Low	Low Low High High	Low Medium Medium Medium	Low High Low Low
YEAR	TOTAL EMPLOYMENT					
1960	1.06	1.05	1.04	1.06	1.05	1.04
1962	1.08	1.08	1.07	1.07	1.06	1.07
1965	1.12	1.11	1.11	1.10	1.10	1.11
1970	1.17	1.18	1.19	1.15	1.16	1.18
1975	1.23	1.26	1.28	1.19	1.21	1.25
1980	1.29	1.33	1.37	1.25	1.28	1.32
1990	1.42	1.49	1.57	1.35	1.41	1.50
2000	1.57	1.68	1.80	1.47	1.56	1.68
YEAR	EMPLOYMENT IN SECONDARY INDUSTRY					
1960	.36	.36	.35	.36	.36	.35
1962	.37	.37	.36	.36	.36	.36
1965	.38	.38	.37	.37	.37	.37
1970	.39	.40	.39	.38	.39	.39
1975	.41	.42	.42	.39	.40	.41
1980	.43	.44	.44	.41	.42	.43
1990	.46	.48	.50	.43	.45	.48
2000	.50	.53	.56	.46	.49	.53
YEAR	EMPLOYMENT IN TERTIARY INDUSTRY					
1960	.70	.69	.69	.70	.69	.69
1962	.71	.71	.71	.71	.70	.71
1965	.74	.73	.74	.73	.73	.74
1970	.78	.78	.80	.77	.77	.79
1975	.82	.84	.86	.80	.81	.84
1980	.86	.89	.93	.84	.86	.89
1990	.96	1.01	1.07	.92	.96	1.02
2000	1.07	1.15	1.24	1.01	1.07	1.15

Table XII

FORECASTS OF LABOR FORCE FOR THE UNITED STATES BY GROWTH ASSUMPTIONS
(Millions of Equivalent Full-Time Workers)

GNP	High	High	High	Low	Low	Low
POPULATION	Low	Medium	High	Low	Medium	High
PARTICIPATION	High	Medium	Low	High	Medium	Low
PRODUCTIVITY	High	Medium	Low	High	Medium	Low
YEAR			TOTAL EMPLOYMENT			
1960	62.9	62.5	62.1	62.9	62.5	62.1
1962	64.38	64.5	64.3	64.3	64.1	64.2
1965	66.93	67.5	67.5	67.	67.0	67.5
1970	71.33	72.3	73.3	71.	71.7	73.1
1975	76.15	78.	80.5	75.5	78.3	79.5
1980	81.39	84.2	88.	80.1	83.1	86.8
1990	93.64	98.2	105.	92.1	96.7	103.
2000	108.04	115.20	126.00	105.12	112.26	122.50
YEAR		EMPLOYMENT IN SECONDARY INDUSTRY				
1960	21.5	21.4	21.3	21.5	21.4	21.3
1962	22.08	22.1	22.1	22.	22.	22.
1965	23.00	23.1	23.3	23.	23.	23.2
1970	24.53	25.	25.4	24.5	24.7	25.2
1975	26.20	26.9	27.7	26.	26.6	27.3
1980	27.95	28.9	30.2	28.	28.5	29.7
1990	31.75	33.4	35.7	31.3	32.8	34.8
2000	36.05	38.70	42.12	35.33	37.46	40.7
YEAR		EMPLOYMENT IN TERTIARY INDUSTRY				
1960	33.9	33.7	33.5	33.9	33.7	33.5
1962	35.04	35.2	35.	35.	34.8	35.
1965	37.02	37.5	37.1	37.	36.9	37.2
1970	40.47	40.8	41.1	40.	40.3	41.
1975	44.16	45.	46.3	43.5	45.3	45.5
1980	48.13	49.5	51.5	46.5	48.6	50.6
1990	57.40	59.7	63.5	56.	58.5	62.1
2000	68.20	72.01	78.48	65.70	69.98	76.0
YEAR		EMPLOYMENT IN PRIMARY INDUSTRY				
1960	7.5	7.4	7.3	7.5	7.4	7.3
1962	7.26	7.2	7.2	7.3	7.3	7.2
1965	6.91	6.9	7.1	7.0	7.1	7.1
1970	6.33	6.5	6.8	6.5	6.7	6.9
1975	5.79	6.1	6.5	6.0	6.4	6.7
1980	5.31	5.8	6.3	5.6	6.0	6.5
1990	4.49	5.1	5.8	4.8	5.4	6.1
2000	3.79	4.49	5.4	4.09	4.82	5.8

Appendix B; MATHEMATICAL FORMULATION OF THE MODEL

In the discussions above, the model and the relationships established in the model have been talked about in non mathematical terms. This was done for the convenience of the non-technical reader who normally does not wish to deal with mathematical formulas and to translate the symbols used therein. The following is a statement of the model in mathematical terms.

The basic relationship of the model is that economic output of the nation or a region, Net Product, is equal to the labor force of the region times the net productivity of labor. This may be written as

$$NP = L\ T \qquad (1)$$

where:

NP - is the dollar value of the net production of the region.

L - is the average annual equivalent full time labor force and

T - is the net worker productivity, measured in terms of the annual value generated by labor.

Net worker productivity was determined in this study from known values of Net Product and labor force using the identity

$$T = \frac{NP}{L} \qquad (2)$$

Labor force may be expressed as some share of the total population, viz.,

$$L = P\ e \qquad (3)$$

where

P - is the total population of the region, and

e - is the ratio of labor force to population, i. e., the participation rate.

Thus, by substituting the equality expressed in equasion 3 in equasion 1, the latter may be rewritten as

$$NP = P \; e \; T \qquad (4)$$

This formulation is used for the purpose of making regional projections of Net Product by incorporating in it rates of change for population, productivity and participation rate, viz.,

$$_{j}NI_{t+e} = {}_{j}P_{t}(1+p)^{e} \; {}_{j}e_{t}(1+r)^{e} \; {}_{j}T_{t}(1+z)^{e} \qquad (5)$$

where

$_{j}NP_{t+e}$ - is the Net Product of region "j" at some year in the future "e" years hence.

p - is the annual rate of change in population.

r - is the annual rate of change in the participation of the population in the labor force, and

z - is the annual rate of change in net worker productivity.

It will be noted that the historical rates of change may be determined between any two years for which the basic information is known.

Under this formulation regional growth in Net Product can occur only through growth in population or productivity or through a larger portion of the population participating in the labor force. It is well known that the growth and decline in regional production is not merely the result of intraregional forces. The region's relation to other regions and their demands for goods will influence the local economy. Thus, to Net Regional Product must be added an increment in production which represents the impact of extraregional factors on the local

economy. Net Regional Production plus this additional increment equals the gross production of the region, i.e., the Gross Regional Product.

As defined by Isard,* the potential of income produced by any region "i" on another region "j" is the measure of the influence of income at a distance. The measure of income potential at any point in time is the income in the distant region divided by the distance between regions, viz,

$$ {}_jV = \frac{g\,{}_iY}{d_{j,i}} \qquad (6) $$

where

${}_jV$ is income potential or the potential of income in region "i" to generate income in region "j",

g is a gravitational constant which subsequently is cancelled out in evaluating the change in income potential,

${}_iY$ is the total income of region "i",

$d_{j,i}$ is the economic distance from region "j" to region "i".

When V is low, region "j" is presumably far from markets and/or the purchasing power of the market area is low. If resource factors are not considered, a low income potential indicates that region "j" tends to have few interregional relations because of the high transport costs to markets and/or because the demand for goods in region "i" is low. Where income potential is high, many interrelations can be expected.

Equation 6 is the formulation for evaluating the potential effect of income in a two region economy. In an "n" region

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* Isard and Freutal, *Op. Cit.*, P. 436

economy, where "n" is any positive number, the income potential for a particular region "j" is the sum of income potentials computed separately for each region, viz.,

$$ {}_{j}V = \frac{{}_{i=1}Y}{d_{j,i=1}} + \frac{{}_{i=2}Y}{d_{j,i=2}} + \ldots + \frac{{}_{i=n}Y}{d_{j,i=n}} \qquad (7) $$

which can be stated more simply as

$$ {}_{j}V = \sum_{i=1}^{i=n} \frac{Y_{i}}{d_{j,i}} \qquad (8) $$

If the unequal distribution of resources among regions is considered it would be necessary to modify the income potential "${}_{j}V$" as noted in equasion 7 and 8. Let "B" be a number which modifies the economic distance between regions, such as to reflect the unique resources of the two regions and the trade pattern between them. Thus the economic distance between regions "i" and "j" in computing the impact of "i" on "j" would be written as

$$ d'_{j,i} = \frac{B_{j,i}}{d_{j,i}} $$

where

$d'_{j,i}$ is a measure of the affect of the space between regions "i" and "j" inhibiting region "j" from interaction with region "i" when the character of the resources and production in region "j", the character of the resources and demand in region "i", and the cost of transportation between them are considered.

By incorporating the resource factor in the computation of income potential, equasion 7 would be modified as follows.

$$ {}_{j}V = \frac{B_{j,i=1}}{d_{j,i=1}}\,{}_{i=1}Y + \frac{B_{j,i=2}}{d_{j,i=2}}\,{}_{i=2}Y + \ldots + \frac{B_{j,i=n}}{d_{j,i=n}}\,{}_{i=n}Y \qquad (9) $$

It is unlikely that the resource factors between region "j" and all other regions "i" would be equal. It is unlikely also that the resource factor from region "j" to region "i" would be equal to the resource factor from region "i" to region "j". Thus, in carrying out the analysis to quantify the resource factors, it would be necessary to compute values for n^2 factors for each period of analysis. While this involves a considerable amount of work, it would probably be impossible to obtain all of the information required to do this.

Thus, to simplify the process a single factor may be derived, which reflects the affect of resources on the interaction with all regions considered as a group. This would reduce the number of factors that would have to be derived to "n" for each analysis interval. The result of using a single resource factor for each region "j" would make equal all of the "B" values noted in equasion 9. Thus equation 8 may be restated as:

$$ {}_{j}V = B_{j} \overset{i=n}{\underset{i=1}{}} \frac{Y_{i}}{d_{j,i}} \qquad (10) $$

since

$$ B_{j,i=1} = B_{j,i=2} = B_{j,i=3} = \cdots = B_{j,i=n} \qquad (11) $$

Income potential is a measure as of a given point in time. The determination of the affect of shifts in extraregional economic patterns over an interval on a particular region is achieved by evaluating the annual rate of change in income potential, viz.,

$$ {}_{j}VP_{t,t+\theta} = \left[\frac{{}_{j}V_{t+\theta}}{{}_{j}V_{t}} \right]^{\frac{1}{\theta}} \qquad (12) $$

where

${}_{j}VP_{t,t+\theta}$ is one plus the annual rate of change in income potential in region "j" over a "θ" year period between the years "t" and "t+θ"

In the cases where "B" is assumed to be constant in the preparation of forecasts, only income potential need be evaluated because in the evaluation process, equasion 12, "B" cancels out. In this study, "B" was assumed to be constant for all forecasts. The general equasion for making projections is:

$$ GP_{t+\theta} = P_t(1+p)^{\theta} \; e_t(1+r)^{\theta} \; T_t(1+z)^{\theta} + (VP)^{\theta}(GP_t - NP_t) \qquad (13) $$

where

GP is the gross product of the area for which the forecast is made, i.e., any region or the nation.

However, it is possible to evaluate historical resource factors in two basic ways. The first method would be based upon the estimates of gross regional product for several years. Given these estimates, it is possible to generate values of "B" as a residual in the equasion:

$$ GP_{t+\theta} = P_t(1+p)^{\theta} \; e_t(1+r)^{\theta} \; T_t(1+z)^{\theta} + \frac{B_{t+\theta} \; V_{t+\theta}}{B_t \; V_t} (GP_t - NP_t) \qquad (14) $$

in conjunction with equasion 7. It will be noted that the term $(GP_t - NP_t)$ reflects the level of investment or disinvestment in the base year and is used as benchmark for projecting extra production at some future year. It should be noted also that levels of regional investment, just as net and gross product, are not published and must be estimated. Thus, through

a series of cycles of estimating investment and calculating "B" as a residual and estimating and adjusting "B" and calculating investment as a residual, a range within which the value of "B" lie, may be determined.

The second method of determining the value of "B" may be used in conjunction with method one. The second method is based upon the assumption that the value of "B" over long periods of time exhibits some linear stability of the form,

$$B = at + b \tag{15}$$

or

$$B = bt^a \tag{16}$$

or some other mathematical form, wherein "a" and "b" are constants. By making this assumption and using only labor force, income, and productivity data for the regions and the GNP for the nation, "B" values for the regions may be determined using regression analyses and other statistical techniques.

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